Queensland.

DEPARTMENT OF MINES.

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Geological Survey of Queensland.

(B. DUNSTAN, F.G.S., CHIEF GOVERNMENT GEOLOGIST.)

PUBLICATION No. 256.

THE CHARTERS TOWERS GOLDFIELD.

BY

J. H. REID, A.S.T.C.,

GOVERNMENT GEOLOGIST.

BRISBANE:

BY AUTHORITY: ANTHONY JAMES CUMMING, GOVERNMENT PRINTER.

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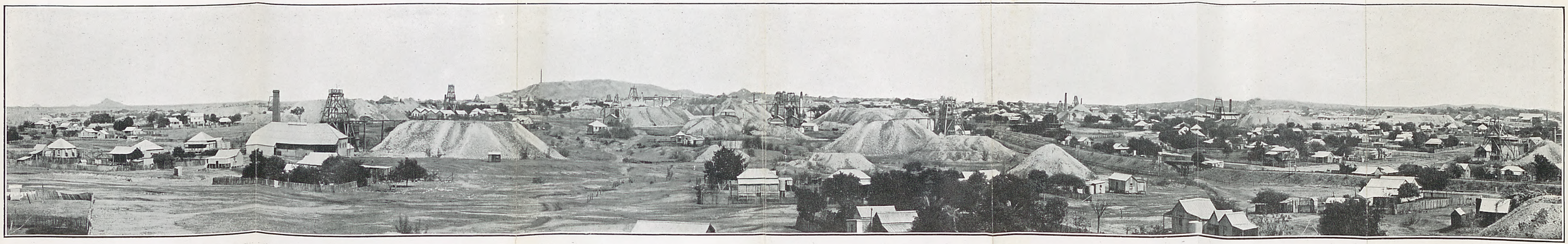

Frontispiece.

VIEW OF CHARTERS TOWERS, SHOWING THE PRINCIPAL MINING AREA.

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MAP.

Geological Map of Charters Towers Field, scale 8 chains to one inch (published separately)

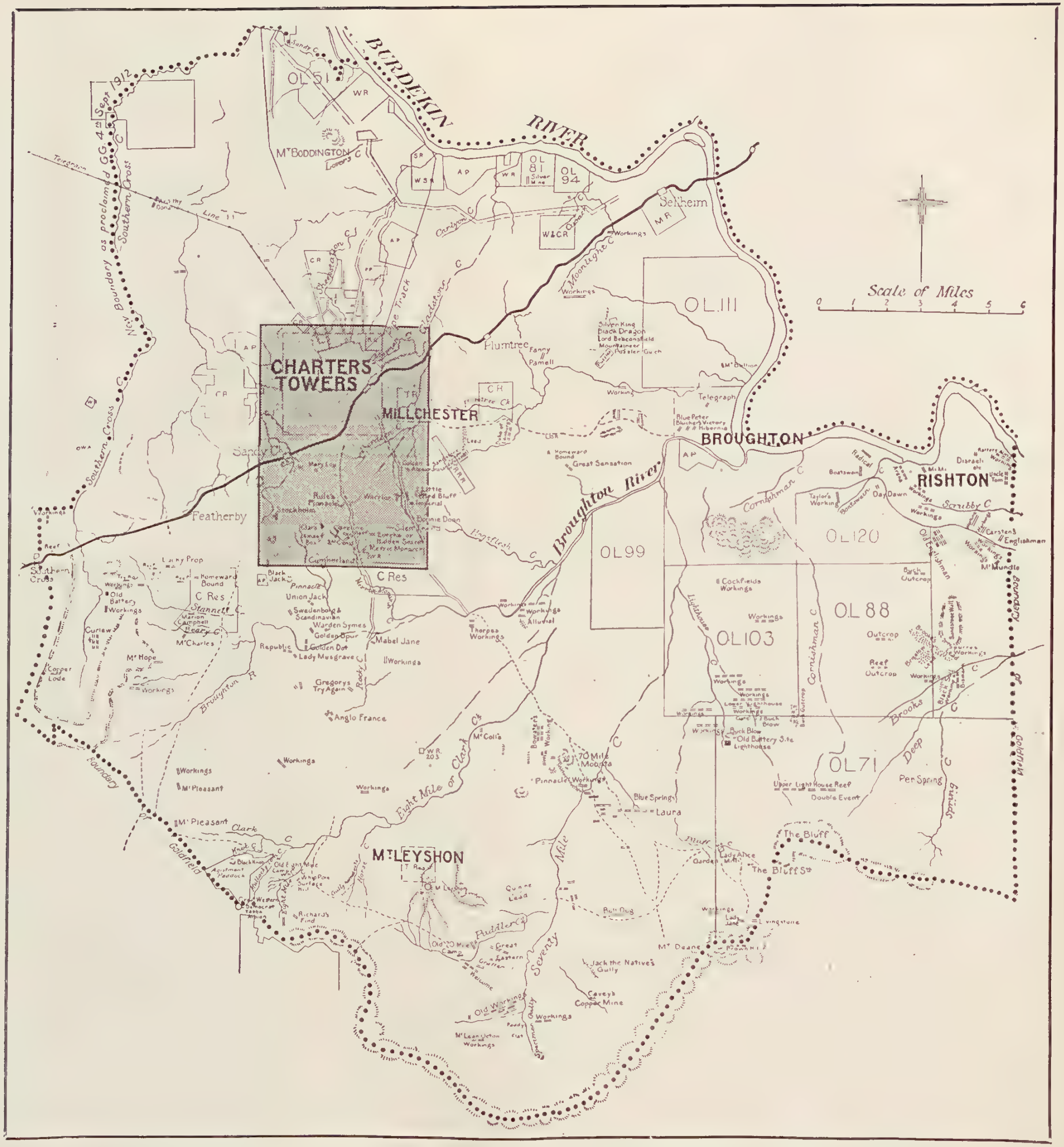


PLATE 1.—MAP OF CHARTERS TOWERS GOLDFIELD, SHOWING POSITION OF "OUTSIDE" MINES.

TAKEN FROM GEOLOGICAL SKETCH MAP BY E. O. MARKS, LATE ASSISTANT GOVERNMENT GEOLOGIST, ACCOMPANYING Q.G.S. PUB. 238.

(Shaded portion embraces area dealt with in present Report.)

THE CHARTERS TOWERS GOLDFIELD.

INTRODUCTION.

Field Work and Acknowledgment.

The Charters Towers gold reefs were discovered late in the year 1871. Up to the present time no detailed account of the ore deposits or the geology of this important field has been published. Between the years 1892 and 1894, Messrs. R. L. Jack, W. H. Rands, and A. G. Maitland were engaged at different intervals on the geological survey of the field, which, besides the areal geology, included an underground survey. As a result of this work, a geological map, on a scale of 4 chains to an inch, was published in 1892, and an edition on which the underground workings of the mines were plotted, appeared in 1898. No detailed report accompanied this map, but some notes on the geology of the field appeared in the Annual Progress Report of the Queensland Geological Survey for the year 1892. Other references to the field appear in the list of literature.

In the present work the area mapped has been extended and embraces 36.3 square miles, including and surrounding the City of Charters Towers and the principal auriferous belts (see Plate 1). The whole of this area has been topographically surveyed, including a resurvey of the portion covered by the old geological map, the new map showing contour intervals of 10 ft. This work was started by the late Mr. C. H. W. Thom (killed in action in Gallipoli, 1915), and completed by Mr. E. Lymburner towards the close of 1914. All important shafts and workings have been located on the map. The field work of the geological survey was commenced in April, 1914, and completed February 2nd, 1915. The only portion of the field covered by the former map which has not been geologically remapped is that which lies between the Sunburst Mine and Gladstone Creek, to the north of Millchester. There is a great reticulation of igneous dykes which would have taken many months to traverse, and the economic value of the work not being apparent, the positions of the dykes which had been carefully mapped by Mr. A. Gibb Maitland in 1892 were transferred from the old to the new map. The underground survey and mining work was then undertaken and finished

on the 15th May following. In all this work I was most efficiently assisted by Mr. C. C. Morton, Geological Assistant, and a graduate of the Charters Towers School of Mines, whose local knowledge was of great value. After assisting me in the office until August, 1915, Mr. Morton enlisted for active service abroad with the Australian Imperial Forces.

Owing to the decline of mining on the field during the past five years, which involved the closing down of many of the larger mines, particularly within the Queenton area, the opportunity had passed, when the present work was undertaken, for preparing the most exhaustive report on the field. Many of the workings in the closed mines could not be inspected, mainly because of non-ventilation, but also on account of levels being closed by falls. However, in addition to all operating mines, many of those closed down were examined.

The bountiful rains of the wet season of 1913-14 greatly increased the difficulty of the field work, making it a matter of slow and painstaking effort to trace rock outcrops in the luxuriant growth of spear-grass which thickly covered many parts of the field to a height of 3 ft. This was a great contrast to the last few months spent on the field, when, after the usual wet season rains failing to eventuate (1914-15), almost every dyke and rock outcrop stood boldly outlined. To all the mine directors, managers, secretaries, and other gentlemen interested in the industry, sincere thanks are extended for their help and courtesy. They have voluntarily proffered information, and allowed without any strictures the use of all plans and sections available. To the Warden (Mr. J. C. Linedale, P.M.), the Director of the School of Mines (Mr. H. I. McGillivray, M.A.), and members of the School of Mines Staff, I am indebted for the use of material and information which have greatly assisted in the preparation of the report. Dr. H. C. Richards and Mr. A. B. Walkom, B.Sc. of the Brisbane University, I have to thank for cordial assistance given in taking photos of micro sections of the igneous rocks as well as for the use of apparatus. Most of the photographs illustrating the report were taken by Mr. P. Harvey (School of Mines Staff) and Mr. C. C. Morton.

SUMMARY.

The Charters Towers Goldfield is situated on an elevated plain at a general level of 1,000 ft. above the sea. Gold was discovered late in the year 1871 by Messrs. Hugh Mosman, George Clarke, and J. Fraser. For many years the field had the greatest output of gold in Australia amongst individual fields.

The maximum annual yield was 319,572 oz. *fine* gold obtained in the year 1899. Since the year 1903, when the yield was 285,771 oz. *fine*, there has been a marked and steady decline in gold production due to the exhaustion of the known shoots of ore, and the increasing poorness of the lodes in depth and, to a lesser extent, to the increased cost of mining. The returns in 1916 were 42,095 oz. *fine* gold. Gold is the staple metal, but from the concentrates from the auriferous ores, some silver and lead are extracted, the yields for 1916 being 21,804 oz. silver and 37 tons of lead. At the present time the field is only exceeded by Mount Morgan in the output of gold from individual fields in the State.

The decreasing output of gold is adversely affecting the prosperity of the city, as it has been almost solely dependent on mining for its existence in the past. The more important mines are gradually closing down or being tributed, and under this state of affairs, the population is gradually decreasing. In 1899 the population of the goldfield was estimated to be 26,215* and in 1915 it had fallen to 15,960*. A spirit of depression hangs over mining operations and capital from any source is now almost impossible to attract for new prospecting ventures. So much prospecting work has been done during the past five years, partly with Government subsidies, with no new discoveries of ore promising persistence, that the pessimism which hangs over the field is not unnatural. It appears unlikely that the annual decrease in gold production will be arrested in the future.

Geology.

On the Charters Towers field, there are two groups of rocks of sedimentary origin and a complex series of igneous rocks. The auriferous country is confined to the latter. The rocks of sedimentary origin are classed as follows:—

Pre-Devonian (metamorphic series).—Schists, slates, and phyllites; quartzite; altered limestone.
Tertiary(?).—Grits and sandstones with clay bands.

The Tertiary(?) grits in two instances at least overlaid shallow leads, now worked out and abandoned, containing alluvial gold. The metamorphic series are strongly folded and are practically non-auriferous. They include mica-, andalusite-, and chlorite-schists. No fossils have been found in them and their age is not definitely known. The common rock of the field appears in field specimens as a grey biotite-granite. It is locally called granite, but microscopical examination and chemical analysis prove it to be a grano-diorite, so it is to be noted in reading this

* Official estimates by the Warden of the Field.

report that grano-diorite refers to the "granite" of the field. This rock occupies about four-fifths of the area of the field, and it contains the auriferous lodes. As regards relative age, it intrudes the metamorphic Series, and is therefore of later age. The grano-diorite is intruded by an extensive series of igneous rocks—at least eight different intrusives have been identified. They range from aplitic granite to gabbro, but rocks of dioritic facies predominate. Two groups of these—the older and younger diorite-porphyrite dykes—show a striking geographical distribution in relation to the gold deposits. Their chronological sequence can be pretty accurately established, but no definite geological age can be assigned.

Three systems of faulting were recognised in the grano-diorite. In chronological order they are north-south faults, mostly hading east; east-west faults, mostly hading north and a series of small, more or less vertical, faults, which can only be traced by slight dislocations in dykes or reefs in mine workings. There are several large faults which cannot be correlated with these systems.

The north-south faults, and particularly the east-west faults, have formed the fissures in which the auriferous ores have been deposited. There was but slight rock movement in the formation of these fault fissures, which are of the nature of normal faults. This is proved by the measurement of dislocations of igneous dykes. Both the Brilliant and the Day Dawn, the two main lode systems of the field, occupy east-west fissures. The lode fissures post-date the igneous intrusions and antedate the Tertiary(?) beds.

Ore-deposits.

The occurrence of the gold ores is causally connected with fault fissures in the grano-diorite—*i.e.*, the lodes may be considered true fissure lodes. The lode material consists of crushed grano-diorite, termed "formation," containing quartz reefs, the latter usually carrying pyrite, galena, zinc-blende, and native gold. The "formation" does not usually carry gold but pyrite is present as a rule. Other minerals occurring rarely in the reefs include tellurides of gold and silver, arseno-pyrite, chalcopyrite, and calcite.

The lodes approximating to a north-south strike dip easterly at angles ranging from 27 degrees to 36 degrees. Those belonging to the east-west system dip northerly at angles ranging from 23 degrees to 40 degrees, with the exception of the reefs belonging to the Day Dawn lode, which average an angle of about 50 degrees and occasionally increase up to 65 degrees.

In thickness the reefs vary up to 10 ft. or 15 ft. occasionally, but the average thickness may be assumed to be nearer 3 ft. Many reefs which have proved payable did not exceed 1 ft. in thickness. Local bulges occur in which large lenticular bodies of quartz and grano-diorite have proved auriferous. In Mills United Mine, for example, a body of ore was stoped out on the Day Dawn lode about 50 ft. thick, for a distance of nearly 100 ft. The gold shows a usual association in the reefs with the base metal sulphides, pyrite, galena, and zincblende. This is so marked that non-mineralised quartz is generally regarded as barren. There are a number of exceptions in which coarse, free gold was found unassociated with sulphides, a notable instance being in the intermediate and lower levels of the Day Dawn Gold Mines Limited. The amount of gold present does not show any definite ratio to the percentage of pyrite or zincblende, although the latter mineral in some quarters is regarded as the most favourable for gold values in ores. A table of partial analyses of ores shows that as the galena content increases, so does the amount of gold. The presence of galena is therefore favourable to the occurrence of gold in the ores.

The ores occur in enriched shoots of irregular form, only those on the Brilliant and associated reefs having a definite pitch, which is to the east with increasing depth. The Brilliant reef has carried payable ore in several different shoots over a vertical range of almost 3,000 ft., and the Day Dawn about 2,200 ft. The Day Dawn lode has been worked over a distance of 6,600 ft., and to a depth of 2,600 ft. The Brilliant lode has been worked over a distance of about 4,000 ft., and to a depth of 3,000 ft. These lode fissures are persistent to the greatest depths attained and increasing impoverishment has been almost wholly responsible for the cessation of mining operations on them. The Brilliant lode has been penetrated to a depth of 3,040 ft., and carries a reef attaining, in places, a width of 5 ft. There is every indication of the lode living to a much greater depth.

The progressive decrease of values in depth is marked, not only in following individual shoots downwards, but shoots occurring in the lower levels have never been enriched to the extent of those at shallower depths. It is not to be inferred from this that better class ore has not been won at the 3,000 ft. level than at the surface, but it can be affirmed that pay shoots between the surface and 1,000 ft. level were richer than those between 1,000 ft. and 2,000 ft. levels, and that these were correspondingly richer than those between 2,000 ft. and 3,000 ft. levels.

Ore Genesis.

The ores were deposited by aqueous solutions, as testified by the universal replacement of crushed grano-diorite by quartz and the crustified character of many veins and reefs. The minerals of the reefs and gangue are those typical of deposits formed at intermediate depths by ascending waters. In this instance the general composition of these must have been preponderatingly siliceous with smaller but notable percentables of H_2S, alkaline carbonates, and base metals.

The field has been the centre of great igneous activity, and the following evidence appears to warrant the statement that the gold, silver, and some at least, if not all, of the accompanying sulphides are emanations from a rock-magma.

The two main belts of auriferous country are associated with groups of diorite-porphyrite dykes, and although these have rather a widespread distribution over the field, they have by far the greatest numerical development in contact or close to the richest auriferous country. Outside the city area, the largest individual mines—viz., Stockholm, Cumberland, Black Jack, Ruby P.C., and the Imperial—are in proximity to similar dykes.

In contrast to the other igneous rock formations, these dykes carry a much higher percentage of primary pyrite, one of the common minerals of the lodes indicating that the dioritic magma was relatively rich in some of the metals. Tellurides of gold and silver have been found in two of the mines, and the evidence as to the occurrence of tellurium in other areas indicates a genetic connection with igneous rocks.

There is no general circulation of underground meteoric water in the deeper mines, some of the workings in which are perfectly dry. Most of the water in the deep mines is derived from either (1) occasional natural water-channels, or (2) from higher-level mines by drainage.

The evidence relating to the causes of deposition of the ores is obscured by apparently conflicting testimony, and as regards some of the big pay shoots, no evidence can be collected owing to the workings. Change of country rock had definitely no influence, pay shoots and barren lode being both distributed through grano-diorite, quartz-diorite, and less siliceous dioritic rocks indiscriminately.

The evidence of intersections conflicts. Intersections with the lodes are made by aplitic dykes, diorite-porphyrite dykes, and barren quartz veins (rare), all of earlier age, and with faults of later age than the fissures. The pay shoots occur indifferently

to the intersections of the first three named, but as regards the fault intersections, there is evidence both for and against these as influencing the auriferous solutions. There are several noticeable instances of great enrichment, particularly along the Caledonia fault, but even in this case the shoot does not persistently follow the intersection line for any great distance. There are also instances of rich shoots worked in proximity to faults in the Victory and Clark's Worcester Mines.

Decrease of temperature and pressure to which ascending solutions are subjected was doubtless a big factor, but it does not account for the deposition of ores in definite isolated bodies as shoots. Alone it would tend to a more equable distribution of gold and sulphides laterally.

Recent Prospecting Work and Future Prospects.

A vigorous campaign of exploratory work has been carried out during recent years, but no noteworthy discoveries of ore have been made, and this work has now almost ceased. In an endeavour to prove the extension of the Day Dawn lode east of the New Brilliant Freeholds, the following work has been done: a vertical shaft sunk to a depth of 1,760 ft. in Clark's Worcester; a crosscut 450 ft. in length driven south from the Brilliant and St. George shaft at the 1,860 ft. level; the Brilliant Block Shaft sunk to a depth of 2,150 ft., and a crosscut driven north-westerly for 680 ft. at a depth of 2,000 ft., and a crosscut and bore south 400 ft. at 2,150 ft. The lode was proved to exist in the Brilliant P.C. and the Brilliant Block Mines, but considerable driving between the 1,600 ft. and 2,000 ft. levels did not reveal any payable ore.

A crosscut between the Day Dawn and Brilliant lodes from the New Brilliant Freeholds shaft at a depth of 1,522 ft. showed the existence of a few small quartz veins only, not warranting any development.

Further west on the Day Dawn in Mills United Mine, both the main and hanging-wall lodes were explored to a depth of 2,540 ft. for about a distance of 1,000 ft. laterally. An underlie shaft was sunk on the hanging-wall lode to a depth of nearly 2,700 ft. and the country to the north of this has been tested by crosscuts for over 300 ft. from the three bottom levels. The prospects of the Day Dawn lode and its branches, either at greater depth or in horizontal extension, offer little encouragement for further expenditure in prospecting.

On the Brilliant lode, the Brilliant Extended worked down to a depth of 3,000 ft., an underlie shaft penetrating the lode to 3,040 ft., the greatest depth attained in mining on this

field, and incidentally in Queensland with the exception of bores. The grade of ore in bulk is too poor to work at 3,000 ft., and the lower levels have been abandoned, and are now flooded. The New Queen Central vertical shaft was recently sunk to a depth of 1,900 ft., several small reef " formations " only, of little or no promise, being intersected in this work. The Bonnie Dundee, with the assistance of a Government subsidy, located a shoot of ore in one of the numerous fissures lying below the main Brilliant lode at a depth of 1,789 ft. Recent work has not fulfilled the promise of any extensive ore body that was at first anticipated. On the western end of the Brilliant lode the New Brilliant Freeholds have recently sunk an underlie to a depth of 1,800 ft. About 200 ft. of driving at this level exposed a small reef averaging less than 12 in. of poor quality ore and prospects of payable ore existing in this portion of the lode are particularly slight.

Other recent work in the Moonstone area resulted in the working of two small reefs containing patches of rich ore in the Papuan (Moonstone) and Clark's Gold Mines leases. Although they have made fair contributions to the gold yield the past two years, they have not arrested the decline from the field due to the shrinkage of output from the Day Dawn and the Brilliant Mines. From the size of the fissures they cannot be expected to show persistence to any considerable depth. The prospecting shaft which was sunk on the St. George and Moonstone lease to a depth of 798 ft. did not meet with any success.

Amongst the more important mines which have closed down since the beginning of the year 1914 are the following:—Brilliant Central, Mills United, New Queen Central, Brilliant Block, Queen Tribute (New Queen), and the Stockholm.

It is to be expected that the yield of gold will still continue to decrease in the future. On the Day Dawn lode only the New Brilliant Freehold and the East Mexican mines continue working. The former has practically exhausted its ore reserves and the prospecting work done has been so discouraging that there is small hope of the mine reviving. In the East Mexican a lode is being worked which contains small bodies of payable ore, but the prospects are spoiled by the amount of barren lode formation between these. On the Brilliant and associated lodes, the Brilliant Extended, Brilliant Deeps, and the Bonnie Dundee are the only operating mines. In the first-mentioned the ore reserves are exhausted and operations have lately been showing a financial loss. The Brilliant Deeps mine, after a long struggle, is now being worked by tributors. In the Bonnie Dundee, recent work has not proved promising, and the future yields are not likely to assist much in arresting the gold decrease from the field.

It is probable that some of these mines will cease working in the near future. From the extent of prospecting work done during the past five years the probability of further favourable developments on either the Day Dawn or Brilliant lodes appears very slight.

While it would be rash to say that the last important discovery of ore has been made on the field, it may be stated that on no other portion of it is there evidence of a duplication of the geological conditions prevailing over the two auriferous belts, more particularly in the numerous development of the diorite-porphyrite dykes characteristic of them. It seems, therefore, further supported by the great amount of surface prospecting done, that the prospects of very extensive ore-bodies existing outside of those belts are not promising. The existence of unknown auriferous reefs is, of course, probable from a consideration of the distribution of those already worked in various parts of the field, but their discovery will probably be delayed until some chance circumstance reveals them, rather than as the result of any methodical prospecting work that could be carried out, owing to the facts that practically all quartz outcrops showing have been tested to some extent and that considerable portions of the area are covered with a fairly heavy overburden of soil which probably would obscure small reef and rock outcrops.

The decrease in recent years is shown in the following table:—

Annual Returns of Gold Production.

Year.	Tons of Ore Raised.	Gold.	Value of Ore Raised, per Ton.
		Fine oz.	£ s. d.
1914	70,121	62,610	3 17 2
1915	55,066	56,888	4 8 3
1916	33,289	42,772	5 9 11

It appears certain that the returns for the year 1917 will show a further decrease.

Mining and Milling Costs.

These have always been very high and during 1916 ranged from about 50s. to £6 per ton, according to size of reef and the tonnage handled in the various mines. The lowest costs attained on the field—by the Brilliant Extended in 1909—were as follows: Mining, 24s. 11d.; milling, 4s. 3d.; cyaniding, 3s. 9d.; administration, 5d. Total, 33s. 4d. The costs in this mine have increased considerably since, but this is partly due to less tonnage treated.

Chapter I.

GENERAL DESCRIPTION OF FIELD.

The district of Charters Towers was first proclaimed a goldfield on August 29, 1872, but since then it has been reduced in area, and the amended boundaries now enclose 393,600 acres, extending from the Burdekin River on the north and east to the Seventy-mile Range on the south, and the township of Southern Cross on the west. It includes the old mining camps of Mount Leyshon, Rishton, and The Broughton, as well as a great many small mines scattered about; but outside of the mines adjacent to and in the city of Charters Towers, there is practically no mining activity at present. Probably over 90 per cent. of the output of gold from the field has been won from within a radius of two miles of the centre of the city. The area which is the subject of this report is all included within a radius of five miles of the centre of the city.

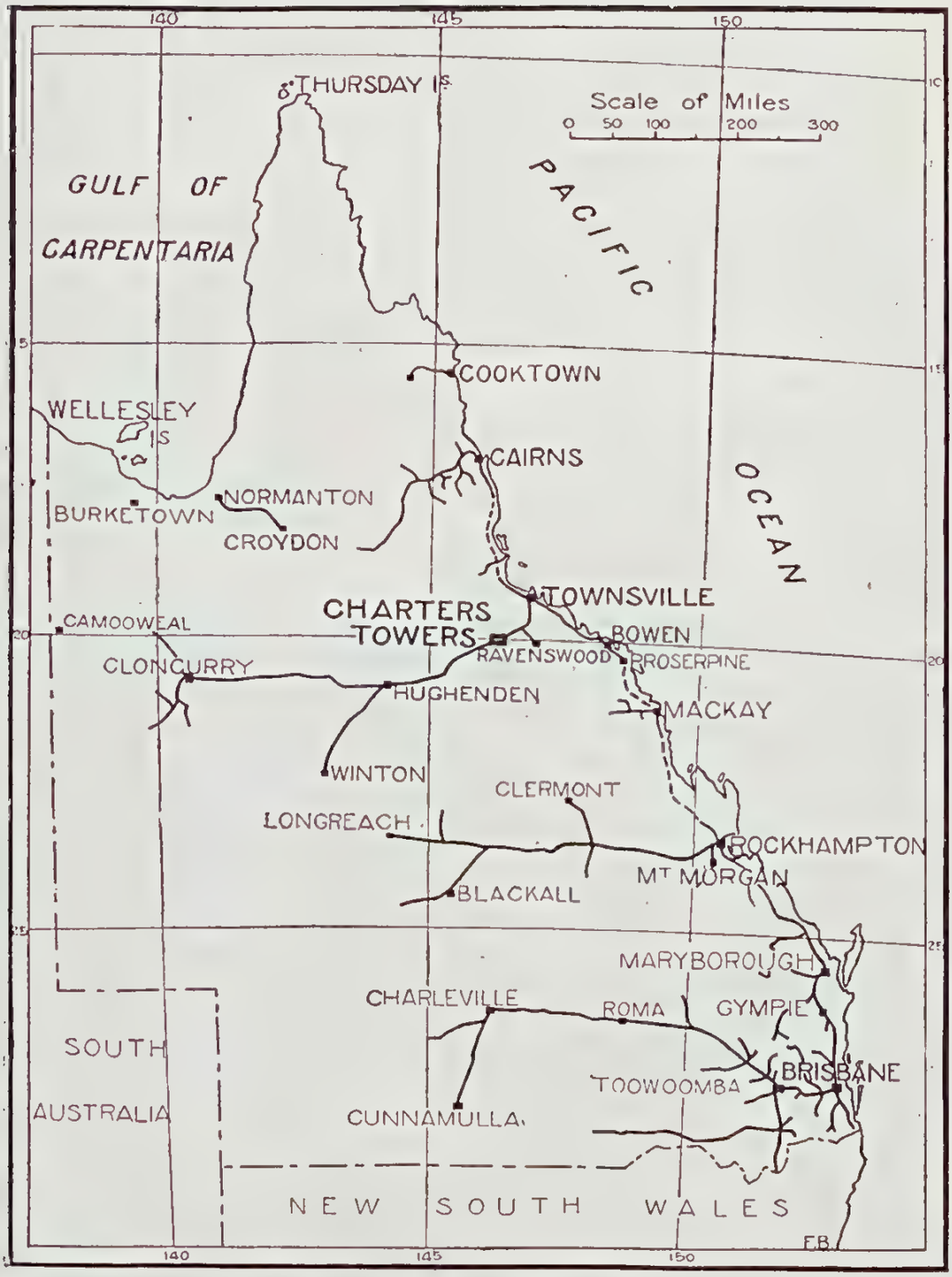
LOCATION AND COMMUNICATION.

The city of Charters Towers (incorporated August, 1877, and declared a city in the year 1909) is at present the second largest centre of population in the district of Kennedy North, and lies on the Great Northern Railway, 82 miles south-south-west of the port of Townsville. Its position is given approximately as latitude 20 degrees 5 minutes south and longitude 146 degrees 18 minutes east. The city is distant from the nearest point of the Burdekin River about seven miles, from which stream a fine water supply is derived. There is railroad communication with the port of Townsville, the coastal towns of Ayr and Bowen, and the mining centres of Ravenswood and Cloncurry. When the connections on the North Coast Railway, already authorised, are completed as far as Proserpine, the city will be in direct railroad communication with Brisbane and the Southern States. The preliminary survey has already been made for the proposed railway from Charters Towers to Clermont, on the Central Railway System.

POPULATION.

Within a radius of five miles of Charters Towers, the census figures are: Year 1901, 20,976 persons; year 1911, 17,298 persons. The Wardens' estimates for the area of the goldfield quoted in the Annual Reports of the Mines Department include the following: Year 1899, 26,215; year 1903, 23,303; year 1915, 15,958.

Plate 2.



MAP OF QUEENSLAND.

SHOWING POSITION OF CHARTERS TOWERS AND RAILWAY SYSTEM.

The population of the goldfield outside of the five-mile radius probably does not exceed 200 persons, so that a big decrease has taken place, and from all appearances is continuing.

CLIMATE AND VEGETATION.

The district enjoys a healthy climate, due chiefly to its elevation of 1,000 ft. above sea level. During the decade ending 1915, the mean monthly shade temperatures have varied between 59.4 degrees (July, 1914) and 86.1 degrees (December, 1911), the extremes registered being, minimum 38 degrees (June 23rd, 1911), maximum 109.5 degrees (November 19th, 1913). The summer temperatures from November to March are trying, but the winter is very mild, slight frosts being occasionally experienced in some portions of the field. For February, in the period mentioned, the mean monthly humidity averaged 67 per cent. (maximum), and for October, 54 per cent. (minimum), while the maximum yearly rainfall was 39.49 in. in 1910 and the minimum 11.76 in. in 1915, the average for the period being 25.25 in.* The greater portion of the rainfall occurs regularly between December and March—the wet season months.

The forest flora of the district is not diverse and consists almost entirely of eucalypts, of which three species predominate, viz., *Eucalyptus crebra* (narrow-leafed ironbark), *E. peltata*, and *E. leptophleba*, the latter two being locally called "yellow jacket" and "bloodwood" respectively—both misnomers. These have been exclusively used for mine timber and fuel on the field, but all the bigger timber has been cut out within a radius of about ten miles of Charters Towers, and the supply is now obtained from the railway sidings on the Ravenswood line and on the Northern railway as far west as the Main Divide. The larger areas of diorite, near Charters Towers, have been cleared of timber, and there appears to be no distinction between the flora supported by the grano-diorite and the metamorphic series (schists and quartzites). In addition to the abovenamed species, which are the dominant forms on both formations, the Moreton Bay ash (*E. tesselaris*) and silver-leafed ironbark (*E. melanophloia*) are seen occasionally, the latter conspicuous in isolated groups at a long distance from its glaucous foliage. Along the shallow watercourses, the paper-barked tea-tree (*Melaleuca saligna*), pandanus, and river-gum are common. On the granite tors or pinnacles, a wild fig is often found. It is only on the Tertiary(?) formation, consisting of grits and argillaceous sandstones, that a distinctive flora is recognised. The sandstone buttes at Millchester Rifle Range and the

* Figures from tables supplied by Commonwealth Bureau of Meteorology.

Little Red Bluff are covered by one of the yellow-flowering wattles (*Acacia torulosa* (?)) attaining a maximum height of 15 to 20 ft. Sandalwood (*Santalum lanceolatum*) is present, but rare, and the shrubs around the base encroach up the sides of the buttes. For a few hundred yards from the base of these, the detrital soil is loose and sandy, and it supports a box tree not seen on other parts of the field. Likewise, the only shrubs seen are confined to this area. These consist of *Dodonæa viscosa* (hop-bush), *Bursaria sp.*(?), *Eremophila Mitchelli* (bastard sandal-wood), and *Atalaya hemiglauca* (whitewood). For determination of specimens of the flora, I am indebted to Messrs. E. C. Andrews, B.A., R. H. Cambage, F.L.S., and J. F. Bailey, Government Botanist of Queensland.

The flora outside of that of the sandstone formation does not appear to have exercised any selective action either as regards soil or shelter, if we except the moisture-loving pandanus, tea-tree, and river-gum. The species previously mentioned are found on either schist or grano-diorite in exposed and sheltered positions. *E. Melanophloia* is distinctly gregarious, but indifferent to position or soil.

The principal natural grasses are the bunch spear-grass (*Heteropogon contortus*) and the three-awned spear-grass (*Aristida vagans*) which grow thickly to a height of about 3 ft. after the summer rains. Kangaroo grass (*Anthistiria ciliata*) "blue" grass (*Pertusus andropogon*) and chloris and couch grasses also abound in parts of the district. The predominating grasses are of indifferent quality for grazing.

SOILS AND CULTURE.

Of soils, there is a wide range. The soil derived from the grano-diorite is light-coloured and sandy, and of poor quality except where enriched by the decomposition of groups of dioritic dykes. As the grano-diorite formation covers the greater part of the field around the city, it is only in smaller and isolated patches that the richer soils are found. The diorite formation, a prominent outcrop of which is on Buckland's Hill, yields a deep red to chocolate coloured soil of excellent quality. The schists and quartzites appear to yield a good soil, but these formations are, near the city, abundantly intruded by diorite dykes which undoubtedly contribute most of the fertilising elements. Along the watercourses there are narrow deposits of sandy alluvium, to which practically all the cultivation is confined. The weathering of the diorite series of rocks appears to be entirely responsible for the presence of rich soils. As an instance on Towers Hill, the writer has seen grass 3 ft. high growing in a narrow strip along

the course of a dioritic dyke, while the grano-diorite soil on either side was almost barren. Many of the dykes could be partly traced by the greener ribbon of couch grass along their course. Samples of soils collected by Mr. G. B. Brooks, Instructor in Agriculture, have been analysed in the chemical laboratory of the Department of Agriculture. These were kindly made available to me by Mr. J. C Brünnich, Agricultural Chemist, and the following analyses selected by me represent the typical soils of the principal rock formations.

Analyses of Soils.

Formation	Schist with dioritic dykes	Diorite	Grano-diorite
Locality	Near Sandy Creek, due west of Charters Towers. Sample No. 6.	Buckland's Hill Sample No. 5.	(Mean of two Analyses.) Samples Nos. 7 and 8.
	Parts per Hundred.	Parts per Hundred.	Parts per Hundred.
Moisture	3·14	2·83	0·86
Humus	2·32	1·29	1·13
Other organic matter and combined water	6·15	5·58	1·51
Chlorine	0·007	0·01	0·02
Nitrogen	0·101	0·079	0·39
	Hydrochloric Acid Extract.	Hydrochloric Acid Extract.	Hydrochloric Acid Extract.
Soluble in H. Cl. Sp. gr. 1·1 — Phosphoric acid	0·096	0·041	0·032
Soluble in H. Cl. Sp. gr. 1·1 — Lime	1·90	0·192	0·271
Soluble in H. Cl. Sp. gr. 1·1 — Magnesia	0·65	0·088	0·132
Soluble in H. Cl. Sp. gr. 1·1 — Potash	0·36	0·412	0·098
Insoluble in H. Cl. Sp. gr. 1·1	68·79	68·24	90·07

The field is sparsely settled, and there is little agriculture beyond the crops grown for the milking herds that supply the city. These are cultivated on the narrow reaches of alluvium along the watercourses and consist principally of maize, sorghum, and lucerne. The climate is not very suitable for cereals such as wheat, as they mature during the dry months of the year. Cotton and sisal hemp have been grown in experimental plots only, under the auspices of the Planters' Association, with entire success. Tropical fruits are successfully grown as frosts are seldom severe enough to inflict injury. A report on the agricultural possibilities of the district was furnished to the Department of Agriculture in the year 1911 by Mr. G. B. Brooks* of that department.

WATER SUPPLY.

This is obtained from the Burdekin weir, completed in the year 1902, which is situated on the river of that name, seven

* Published in the "Northern Miner," newspaper, Charters Towers, 4th August, 1911.

miles distant from Charters Towers. The weir has a capacity of 400,000,000 gallons. A pumping station is situated close to the weir, and a pipe line connects to the reservoir on Towers Hill in the city area. In 1914 there were 201,639,000 gallons delivered into the reservoir. Water for the crushing mills is impounded in dams on the creeks and shallow watercourses. As torrential rains fall during the summer months, surface water is usually quickly impounded in sufficient quantity to ensure a supply except during protracted periods of drought.

LIST OF LITERATURE.

The following list of literature in chronological order, relating to Charters Towers, covers descriptions of the various phases of the mining industry, history, geology, and physiography. As these are scattered through official reports and private publications, some possibly have been unavoidably missed:—

Jack, R. L.—Report on the Geology and Mineral Resources of the District between Charters Towers Goldfield and the Coast. (Two geological maps.) Brisbane, 1879. G.S Q. Pub. No. 1.

Jack, R. L.—Report on the Gold Deposits of Mount Leyshon (geological map). Brisbane, 1885. G.S.Q. Pub. No. 18 (out of print).

Warden, The —History of the Charters Towers Goldfield. Ann. Rept. Mines Dept. Q'land, 1887, pp. 23-27.

A short review of mining and other industrial progress, population, revenue, &c.

Rands, W. H., and Maitland, A. Gibb.—Progress Reports on the Geological Survey of Charters Towers. Annual Progress Report of the Geol. Survey Q'land for the year 1891. G.S.Q. Pub. No 87, Brisbane, 1892.

Includes a brief description of the areal geology.

Jack, R. L, and Etheridge, Jun., R.—Geology and Palaeontology of Queensland and New Guinea. Brisbane, 1893. G.S.Q. Pub. No. 92.

Several references to geology based on earlier official reports.

Clarke, A. W.—Petrographical Notes on Specimens from Queensland, &c. G.S.Q. Pub. No. 92, chapter XL.

Descriptions of thin sections of granites, diorites, &c., from Charters Towers.

Marsland, L. W.—The Charters Towers Gold Mines. London, 1892.

Descriptions of the mines, statistics, &c.

Jack, R. L., Rands, W. H., and Maitland, A. Gibb.—Geological Map of Charters Towers Goldfield, in six sheets (scale 4 chains to an inch). Brisbane, 1892. G.S.Q. Pub. No. 95.

[Same map, 2nd edition, showing underground workings, Brisbane, 1898. G.S.Q. Pub. No. 142.]

Brown, D. A.—The Charters Towers Pyrites Company's Works. Ann. Rept. Mines Dept., Q'land, 1895, p. 53.

A brief note by the Manager on the preliminary smelting of ores for the chlorination process.

The Editor, "North Queensland Register," Newspaper.—Mining History of Charters Towers, 1872-1897. Charters Towers, 1897.

Contains much valuable and authentic information as to the early history of the field, descriptions of the mines and mills, output of gold, and other statistics.

Curle, J. H.—The Gold Mines of the World, pp. 219-233. London, 1899.

Short descriptions of the principal mines and the treatment of ore given.

Blanc, W.—Report on the Conditions and Modes of Working on the Goldfields of Queensland. Ann. Rept. Mines Dept., Q'land, 1900, pp. 37-42.

A report on methods of working the mines and treatment of ores. The writer severely criticises these as being responsible for the abnormally high costs prevailing on the field.

Clarke, D.—Australian Mining and Metallurgy, pp. 255-264. Melbourne, 1904.

Principally devoted to metallurgical methods.

Jackson, C. F. V., Chief Inspector of Mines, Queensland.—State-owned Batteries in the vicinity of Charters Towers. Q'land Govt. Min. Jour., 1905, p. 569-578.

An official report on proposals and suggestions for the establishment of State batteries in the outlying portions of the district.

Maclaren, J. Malcolm.—Gold: Its Geological Occurrence and Geographical Distribution. London, 1908.

Included in a brief outline of the field are descriptions of some of the principal igneous rocks.

Cameron, Walter E.—The Charters Towers Goldfield. Notes on the Main Reefs. Brisbane, 1909, G.S. Q'land Pub. No. 224.

Poole, W.—Notes on the Physiography of North Queensland. Report of Aust. Assoc. for Adv. of Science, 1909. Brisbane, 1910.

Includes a brief reference to the Charters Towers peneplain.

Laun, E. J.—Some "Outside" Mines, Charters Towers. Q'land Govt. Min. Jour., 1911, pp. 120-122.

Descriptions of some of the more important mines outside of the principal auriferous area.

Marks, E. O.—Outside Mines of the Charters Towers Goldfield. Brisbane, 1913. G.S. Q'land, Pub. No. 238.

Includes brief descriptions of the geology, topography, ore deposits, and "outside" mines of the field, accompanied by a sketch geological map of the goldfield with the positions of the "outside" workings located.

Reid, J. H.—Short Reports on Charters Towers mining, which appeared in the monthly numbers of the Queensland Govt. Mining Journal, Brisbane.

(1) *Reefs worked in the past; July,* 1914. (2) *Revival of Mining; July,* 1915. (3) *Recent developments at the Bonnie Dundee Mine; May,* 1916. (4) *Moonstone-Telegraph Mine; May,* 1916.

Chapter II.

HISTORY AND TECHNOLOGY OF THE GOLD DEPOSITS.

DISCOVERY AND DEVELOPMENT.†

Charters Towers was partly named after the first Warden of the goldfield (Mr. W. S. E. M. Charters) and partly from the granite "tors" or "towers" around which gold was first found.

The history of Charters Towers as a mining centre begins with the discovery of gold by a party of prospectors, Messrs. Hugh Mosman, George Clarke, and J. Fraser, near the Gap on the north-western side of Towers Hill, towards the end of the year 1871. This was a momentous incident for the State of Queensland, for further discoveries close to this spot placed Charters Towers for many years in the position of the premier goldfield of Australia, a position successfully challenged by Mount Morgan for several years, and only relinquished finally by the oncoming of Kalgoorlie. To-day, after an interval of forty-five years, it still produces about one-fourth of the gold yield from the State of Queensland, and ranks second to Mount Morgan.

An account of the discovery was written by Mr. George Clarke, and published in 1897 in the "North Queensland Register's" Mining History of Charters Towers. It has been reprinted in several pamphlets on Queensland mines, but, being of great interest, it is fittingly recounted here in the official report of the field.

"The close of the year 1871 found Mosman, Fraser, and myself in the Broughton River country, near what is now known as the Seventy Mile. Some months before we had started from 450 miles south of Ravenswood on a prospecting expedition. We spent some weeks of fruitless searching in and around Ravenswood, which was then a promising goldfield. Then we travelled on westward prospecting the Burdekin River country. Sometimes we got a little gold, but not what we considered payable; still we determined to keep on for a year longer if necessary. The valley of the Burdekin westward and north-west was untried country, and somehow, being young, comparatively inexperienced, and enthusiastic, we were always sanguine of discovering a good goldfield. If not, we determined to go still further north. It was a pleasant life, and, although disappointments were numerous, yet the possibilities, if somewhat uncertain, were great. We prospected the Broughton branches, getting a little gold almost everywhere we tried, becoming more plentiful as we neared the Seventy Mile pinnacles, and we said to ourselves, "Among those hills we will get it very heavy." We were disappointed; we obtained nothing very good, and a

† In this portion of Chapter II. the gold returns mentioned refer to gold bullion the value of which usually ranged from 66s. to 72s. per oz. for mill gold.

party of three or four men, Crichton and others, whom we found working a creek, were getting very little. A considerable quantity of alluvial was afterwards won from this field, which was called the Seventy Mile, it being seventy miles from Ravenswood. Here we remained for several weeks, prospecting country to the south and to the west most of the time. On the top of the pinnacles we found stone carrying gold, and on the slope of the same pinnacle, Jimmy Pile, an old Towers identity, afterwards crushed 100 oz. to the ton and upwards. This, I believe, is now known as the Mount Leyshon Mine.

A cluster of conical and square-topped hills away to the north had often attracted our attention [Towers Hills, where they eventually discovered payable gold—J.H.R.], and we determined to prospect in that direction. We found gold in the locality of the Merrie Monarch lease, but not payable. From these the hills were about four or five miles distant. It was a dry time, the nearest water five miles away in an opposite direction. A storm was near, and while we were deliberating as to whether we should go to the water or camp and trust to the water coming to us, the question was settled rather abruptly. A terrific peal of thunder started our pack

[*Photo., C. C. Morton.*

PLATE 3.—LOOKING ACROSS THE GAP, TOWERS HILL,

Below The Gap (to left) gold first discovered. Clark's Gold Mine in foreground.

horse at his best pace through the bush—an unlucky stampede resulting in the loss of all our cooking apparatus except one tin dish. Rain fell in a perfect torrent, and we camped at once.

The following day we went through a gap between the hills, which had so long formed the subject of our observation, and camped near the outcrop of the North Australian reef. Masses of quartz were strewn about the surface, which we at once saw were very rich, and when afterwards crushed they yielded 3 oz. and upwards to the ton. Stone raised from beneath the surface from the North Australian went 4½ oz. to the ton. The following day we found payable quartz in at least half a dozen places

—reefs afterwards known as the Mary, Wyndham, Moonstone, Ophir, Rainbow, and others. In the Rainbow we got the richest specimens. We prospected for several days, finding other reefs carrying gold, and we then went back and moved our permanent camp from the Seventy Mile to Charters Towers. There was no time for proving reefs by sinking, so after a careful examination of surface blows we selected the North Australian, Ophir, and another, the name of which I forget, as the best, and on 2nd January (1872) Mosman travelled to Ravenswood and applied to Warden Charters for the reward claims. Then the rush set in and in a few weeks there were several hundreds of miners on the field. In the meantime we had found the Washington, Old Warrior, Alexandra, St. Patrick, and others. The Washington was, I think, about the best surface show on the field. From this reef, from the surface alone, we took about 1,600 oz. of gold. The subsequent history of Charters Towers is known to all.''

The warden at Ravenswood, Mr. William S. E. M. Charters, visited the site of the discovery and awarded prospecting claims to Messrs. Mosman, Clarke, and Fraser on the North Australian line, near The Gap, on the 26th January, 1872. This was quickly followed by a rush from the neighbouring mining districts, and so rich was the surface stone that the returns for the year 1872 reached 31,287 oz. Operations were first centred around the North Australian, Rainbow, Wyndham, Moonstone, and St. Patrick reefs, but others were being frequently found, most of which gave spasmodic but rich returns. About 1873 some of the miners turned their attention to Millchester, where alluvial gold had been found in shallow leads surrounding an outlier of ferruginous sandstone and grit. This movement was responsible for the discovery of the outcrops of the Warrior, Washington, Golden Alexandra, and Old Identity reefs, which largely increased the returns from the field in its pioneer days, and some of which have been worked periodically until recent years with varying fortunes. There were many rich discoveries during 1873, and the gold production jumped to 74,746 oz. for the year. The period up to 1877 furnishes a record of steady progress in discovery and shallow development, the chief contributing reefs in addition to those already mentioned being the St. Patrick, Wellington, Alabama, Lady Maria, and the Queen. It should be mentioned here that operations were started on the Day Dawn reef in 1874. It is not clear who actually discovered the famous lode which has been for so long, with the Brilliant, the mainstay of the field, but the first claim which returned crushings was the Day Dawn P.C., held by Mr. F. Pfeiffer and party. The first crushing was obtained in March, 1875, 37 tons of quartz returning 42 oz. of gold. In 1878 the population of the field had reached 4,000, and there was a gradual influx from the Southern States, many of the miners without means having to walk from Townsville over the Range. The chief troubles of the mining camp in

those days were the lack of transportation (for it was a three days' journey by bullock teams from the coast) and the scarcity of water. Many times, the crushing mills had to retard or suspend work as a result of the periodical droughts. Until the advent of the railway the bullion was sent to the port of Townsville every two or three months under Government escort.

The St. Patrick reef headed the returns for 1878 with 13,006 oz. This reef for the first decade in the history of the field outdistanced easily all competitors in gold production, but was then displaced by the Day Dawn. The year 1879 marked the Day Dawn reef's first appearance among the list of chief producers of the field with a return of 2,328 oz., but the St. Patrick again headed the list with 10,775 oz., followed by the Queen with 10,732 oz.

Although the progress of the field had been well maintained up to 1879, it was in the eighties that it won a world-wide renown, and this was achieved almost wholly by the wonderful returns from the mines operating on the Day Dawn reef. The annual returns bounded up until in 1889 the yearly production had more than doubled itself. In 1881 several local companies were floated, among the first being the Day Dawn Gold Mining Company, Limited, and the Victory Gold Mining Company. As instancing the wonderful richness of the ore then being mined, the former company declared 7s. in dividends on each share of 10s. paid-up capital within three months of flotation, while the Victory Company, which purchased its mine for a sum of £8,500, was able to pay £5,000 in dividends from its first crushing within a couple of months of being floated. Such returns attracted attention to the field from other parts of Australia and Europe, and outside capital started to slowly filter into the field, while the steady climb up of the gold returns, synchronising with the exploration of deeper ground, instilled confidence in deep sinking schemes. The railway from the port of Townsville was officially opened on the 4th December, 1882, and thus placed the field in convenient communication with other parts of Australia. From 1881 to 1885 the Day Dawn P.C. Mine was easily at the head of the producing mines, and with the Day Dawn Block and Wyndham was returning nearly half of the output of gold, although the Queen reef had come into prominence with many fine crushings. In 1885 the Eastward Ho had a magnificent crushing of 1,741 tons of quartz for 8,389 oz. of gold, an average of 4 oz. 16 dwt. per ton. The Day Dawn Block and Wyndham was the largest producer for 1886, with a return of 37,950 oz., and during the year was sold to an English company.

The Black Jack group of mines, situated 5 miles south-west of the town, had a successful year, and furnished 8,834 oz. to the total yield, while the shallow and rich workings of the Sovereign and St. George P.C. first came into prominence. The population of the field had increased to 10,185 at this time.

The Day Dawn reef furnished 67,777 oz. of the total yield of 151,498 oz. in 1887, the Day Dawn Block and Wyndham Mine reaching its greatest annual production with a return of 39,191 oz. Other reefs which had good yields were the Victory, St. George, Black Jack, and the Lady Maria, of which the last-mentioned is at the present time being successfully reworked. At this time the mining rights under certain reserves within the city were sold by auction, and these rights under the Boys' State School Reserve, adjoining the lease of the Day Dawn P.C. Mine, with an area of 5 acres, brought the extraordinary price of £5,400 per annum, equivalent to an annual rental of £1,080 per acre for ground, the objective of which was a reef at a depth of 1,000 ft. It was eventually reduced to the usual annual rental of £1 per acre, but it is of melancholy interest to think how little the high hopes founded on such a valuation were justified, for subsequent working proved most of the ground to be unpayable. The following year (1888) the output receded about 14,000 oz., partly due to the collapse of the Black Jack boom. The Victory and the Eastward-Ho mines, however, both had good yields, and the Victoria Mine after some years of development work started on its prosperous career.

The most important development that the field has seen was the cutting of the Brilliant reef in Craven's shaft in the year 1889. This shaft was sunk by Mr. R. Craven to a depth of 900 ft. as a purely prospecting venture in untried country lying between the Day Dawn and Queen reefs. At a depth of 765 ft. a fissure was passed through, but as it looked unpromising sinking was continued. Success not attending this it was decided to open out on the fissure, with the result that within a few feet ore was discovered, the crushing of which averaged 2½ oz. of gold per ton. The excitement following this discovery resulted in all the available ground adjoining being taken up, shafts were hurriedly started to cut the reef in the Brilliant Block and the Brilliant and St. George mines at depths of over 1,000 ft., and the Brilliant Mine itself within two years headed the list of productive mines. This so established confidence in deep sinking that the Brilliant Extended Mine and the Brilliant Extended Block (now Brilliant Deeps) shortly afterwards started sinking shafts, which eventually cut the reef at depths of 2,030 ft. and 2,300 ft., respectively.

The returns in 1891 jumped to 223,403 oz. (of which the Brilliant Mine contributed 36,605 oz.), and a boom in mining shares was created by the splendid returns from the Brilliant, Mills's Day Dawn United, the Golden Gate, No. 7 North-east Queen, and the Victoria, and the cutting of a 12-ft. reef in the Brilliant and St. George Mine. In 1892 there was again a big increase. The Victory Mine, which adjourned the Brilliant Mine on the south-east, sank a new shaft to work the reef found in the Brilliant. The fissure was cut at a depth of 400 ft., but was a blank till followed to within about 300 ft. of the boundary. Here it opened out suddenly, in some places to a width of 12 ft., carrying stone which yielded up to 7 oz. of gold. It was only a small, almost isolated shoot lying right on the boundary, and was worked out within two years, but it is reported to have been the richest piece of ground worked on the field. From this alone the company crushed stone yielding 37,224 oz., and paid dividends amounting to £97,500 for the year. The year 1892 also saw the Victoria and the No. 7 N.E. Queen double their yields over the previous year, and the Golden Gate on the eastward extension of the Queen reef reached its maximum output with 17,802 oz. The year is also noteworthy, for the cyanide process was first introduced on the field by the Australian Gold Recovering Company. By the year 1893 the population of the field had reached 19,000. Mills Day Dawn United Mine was working the big shoot of rich ore in their upper levels, and with a return of 51,471 oz. for the year they distributed dividends to the amount of £97,500, while the Victory from the Brilliant shoot within their boundary paid a further £80,000 to their shareholders. The following year Mills United again distributed £101,250 in dividends, and for a period had become the premier mine of the field. With the falling away of this mine in 1896, due to the exhaustion of the upper shoot, the next few years saw the Brilliant and St. George, Brilliant P.C., and Day Dawn Block and Wyndham at the top of the list, while the Victoria Mine steadily produced large quantities of high-grade ore, and the Papuan, Brilliant Block, and the Brilliant Extended made their first appearance amongst the list of highly productive mines. The Brilliant Extended Block shaft had been sunk to a depth of 2,558 ft. by the end of 1896, but the Brilliant reef, which was cut at 2,300 ft., proved unpayable. The company continued driving their east levels towards the Brilliant Extended in the hope of picking up the shoot worked there, but with no success.

The great increase in the annual output of gold from 1896 to 1899 was due entirely to the successful treatment by cyanide of the enormous heaps of old tailings. Ever since the inception

of the field these had been accumulating at the mills and chlorination works, and the original low percentage of extraction evidenced by the cyanide returns speaks volumes for the richness of the ore in the early days when with these losses the mill's returns averaged 35 dwt. to 2 oz. per ton of ore. In 1898 there were ninety-six cyanide plants working at full pressure along the creeks within the purlieus of the city. In the year 1899 the gold output of the field reached 511,021 oz.,* the high-water mark of production in its history, but of this 278,256 oz. resulted from treatment of tailings, and 224,773 oz. were returned from the crushing mills. In the ensuing years up to 1902 the fall in annual production was due to the exhaustion of the supply of old tailings. The Queen Cross Reef lease caused a boom in Queenton leaseholds in 1902 by exceptionally rich returns from a reef cut at a depth of 948 ft. Years previously the company had worked several reefs, including the Brilliant, with success, but the "948-ft. formation," as it was called, had been neglected. On opening out on this reef the returns created one of the sensational booms of the field. The returns from this mine for 1902 were 41,663 oz. gold, dividends £116,666; 1903, 78,303 oz. gold, dividends £215,000; 1904, 79,686 oz. gold, dividends £220,000; 1905, 26,677 oz. gold, dividends £62,500. The adjoining mine, the Victoria and Queen, also struck a rich shoot close to the Queen Cross boundary, and paid £44,350 in dividends during 1904, but it then became exhausted. The ore shoot in the Queen Cross overlapped into the adjoining mines, the Band of Hope and the Queen Central, but was never picked up in the Vesuvius lease to the east, where prospecting for it was carried on unsuccessfully. The year 1902 marked the completion of a weir constructed on the Burdekin River, about 7 miles from the city, which since then has been assured of an unfailing domestic supply. The returns for 1903 eclipsed anything in the history of the field for the amount of ore raised and gold recovered from it, the greater yields of gold in previous years resulting from the cyaniding of accumulated tailings. The period from 1905 onwards marked the decline of the Queen Cross, Brilliant and St. George, and Brilliant Central, three of the great mines of the field, and the rise from temporary obscurity of Mills's Day Dawn United, which had discovered a large shoot of ore in the lower levels trending towards the New Brilliant Freeholds lease. The Brilliant Extended also increased their yield; and the Ruby, a smaller mine to the south of the city, was having a prosperous career. These, however, were unable to arrest the annual decrease in gold yield, but this period also marked an

* 319,572 oz. fine gold, discrepancy due to low value of cyanide bullion.—J.H.R.

era of vigorous prospecting in various parts of the field, none of which, however, was attended with any great success. Exploration had been going on down to 1,200 ft. on the western extension of the Day Dawn reef in Wallis's Day Dawn and the Day Dawn Gold Mines. The Queen Deeps had been testing the Queen reef down to a depth of 1,300 ft. on the eastern side of the field; and in the Queen Cross Mine a diamond drill bore was put down to 3,000 ft. without discovering any payable ore. The search for the easterly extension of the Day Dawn reef was also unrewarded, as Clark's Brilliant and Day Dawn continued their shaft to a depth of almost 1,800 ft., and the Brilliant and St. George put in a crosscut 480 ft. south from the 1,860 ft. level in their mine without intersecting the reef. From 1909 to the present year Mills's United, Brilliant Extended, and New Brilliant Freeholds have been the principal producers of payable ore, while the only discoveries of any note were the "footwall" reef which was unexpectedly found in the lower workings of the Brilliant Deeps, still being worked, and a reef in the Bonnie Dundee Mine at the 1,789-ft. level. Considerable prospecting has been carried out in the deeper ground of the Brilliant and the Day Dawn lodes, particularly in Mills's United (to a depth of nearly 2,700 ft.), in the Brilliant Deeps, and in the New Brilliant Freeholds, where the underlie shaft on the Brilliant lode was carried down to a depth of 1,800 ft. These efforts have been practically resultless as prospecting work.

The exhaustion of ore reserves and the results of the work just mentioned have caused many of the principal mines to close down during the past five years, but a few of the companies concerned have taken up leaseholds on the Moonstone area, to the south-west of the city, in two instances, so far, with some success. The Papuan Brilliant and Victoria Gold Mining Company, after working the Moonstone reef for several years, discovered fortuitously a small cross reef carrying exceedingly rich ore, and have until lately been regularly paying dividends. Clark's Gold Mines (formerly Clark's Day Dawn and Brilliant) are working the Lady Maria with success. The returns from these two mines greatly diminished the annual decline of gold from the field from 1914 to 1916, but they cannot be expected to do so for any length of time, for both are working small reefs which do not promise any great persistence either at increased depth or in horizontal extension.

The great decrease of gold during the past decade has left the field in a state of depression, and capital for developing what are locally considered fair prospects is extremely difficult to obtain.

Plate 4.

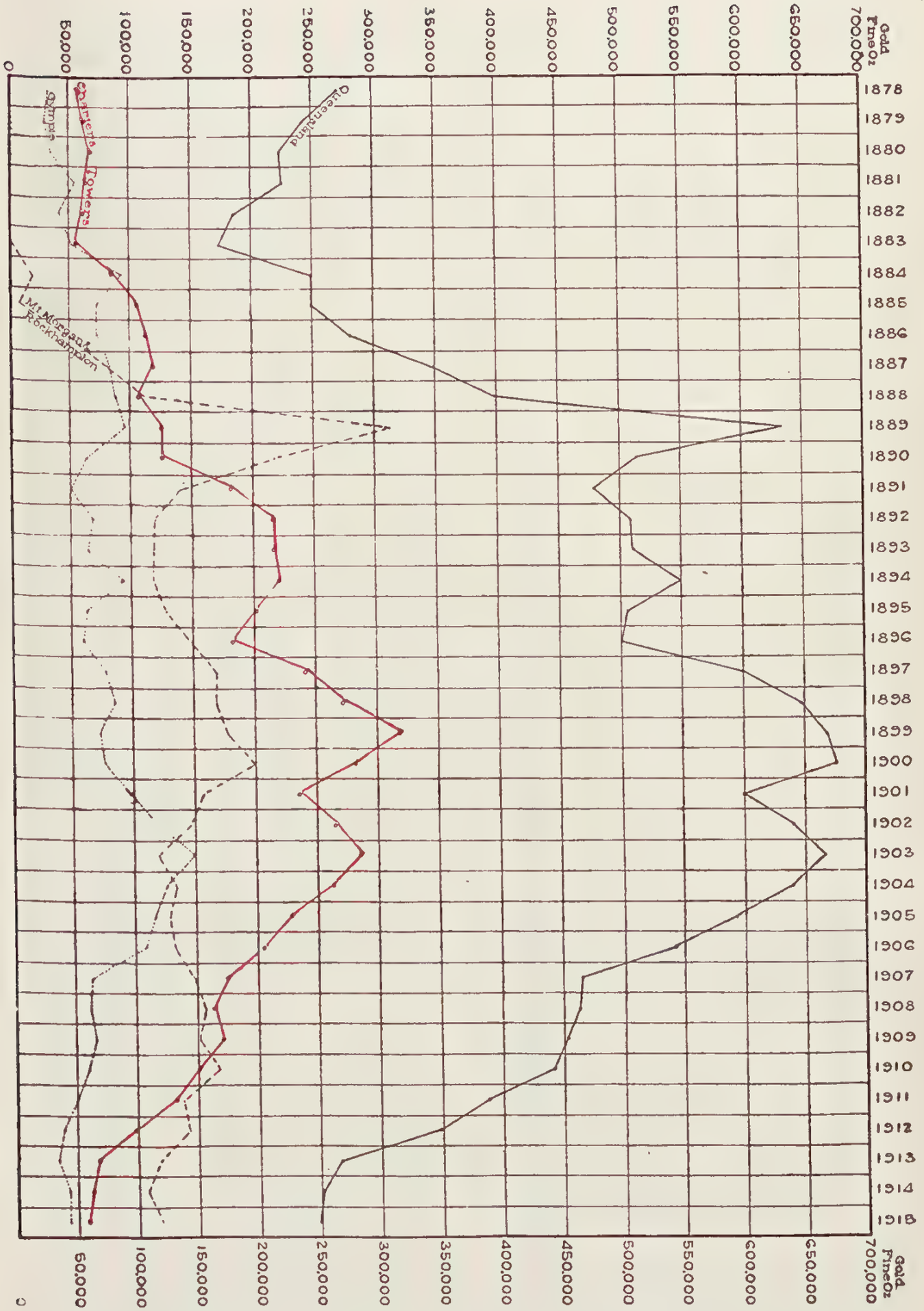


CHART SHOWING GOLD PRODUCTION OF CHARTERS TOWERS, MOUNT MORGAN, GYMPIE, AND STATE OF QUEENSLAND.

PRODUCTION.

The appended returns are taken from the Annual Reports of the Department of Mines, Queensland. The gold returns include those from the adjacent Cape River Goldfield, where auriferous leads were worked as early as 1869, but for many years the field has been practically abandoned. "The estimated gold returns from Cape River since 1878 are so small as to scarcely affect the Charters Towers returns."* The silver and lead returns are from the Charters Towers gold ores, and the totals are based on assays of the concentrates sold from the field.

GOLD, SILVER, AND LEAD RETURNS, CHARTERS TOWERS.

Year.	Ore Raised.	Gold.	Silver.	Lead.
	Tons.	Fine oz.	Oz.	Tons.
To end of 1877	..	493,558	..	..
1878	35,509	59,482	..	..
1879	41,584	63,715	..	..
1880	39,285	67,773	..	..
1881	45,378	65,410	..	..
1882	45,663	63,242	..	..
1883	44,602	55,264	..	..
1884	52,561	86,228	..	..
1885	70,164	106,981	..	..
1886	77,665	112,166	..	..
1887	82,853	117,603	..	..
1888	81,698	106,839	..	..
1889	108,828	126,666	..	..
1890	121,406	127,426	..	..
1891	173,789	183,830	..	..
1892	186,392	216,679	..	..
1893	180,208	216,660	..	..
1894	224,294	221,544	..	..
1895	230,672	200,916	..	..
1896	176,112	181,923	41	..
1897	198,873	242,641	637	..
1898	209,978	272,368	802	..
1899	209,802	319,572	2,334	..
1900	206,205	283,237	4,283	1
1901	214,595	235,302	18,980	4
1902	221,098	265,244	34,916	73
1903	247,481	285,771	15,583	24
1904	241,200	262,018	38,733	184
1905	224,519	226,696	58,887	404
1906	240,416	205,632	80,878	497
1907	211,090	175,552	98,696	361
1908	193,858	162,270	132,520	364
1909	187,454	171,654	118,505	451
1910	168,619	147,484	115,109	414
1911	175,803	133,833	88,466	393
1912	136,431	96,046	60,784	189
1913	79,139	69,982	47,229	161
1914	70,121	62,610	35,501	76·5
1915	55,066	56,888	25,877	50·5
1916	33,107	42,777	21,804	37
Totals to end of 1916 ..	..	6,591,482	1,000,565	3,684

* W. H. Rands. The Cape River Goldfield. G.S.Q. Pub. 73, p. 18 (1891.)

DIVIDENDS AND CALLS, CHARTERS TOWERS MINES.

Year.	Dividends.	Calls.	Year.	Dividends.	Calls.	Year.	Dividends.	Calls.
	£	£		£	£		£	£
1890 ...	152,812	106,231	1899 ...	301,535	67,222	1908 ...	100,980	60,522
1891 ...	255,020	95.311	1900 ...	299,205	56,241	1909 ...	156,819	57,475
1892 ...	341,692	112,521	1901 ...	271,113	43,001	1910 ...	112,190	58,921
1893 ...	300,898	61,889	1902 ...	415,157	103,746	1911 ...	131,635	64,283
1894 ...	289,074	50,999	1903 ...	460,042	129,681	1912 ...	35,981	36,023
1895 ...	244,800	91,761	1904 ...	399,128	83,067	1913 ...	49,842	37,411
1896 ...	254,616	130,747	1905 ..	219,610	93,461	1914 ...	5,978	22,407
1897 ...	343,318	93,557	1906 ...	176,602	125,134	1915 ...	27,907	10,875
1898 ...	308,588	81,093	1907 ...	120,099	81,863	1916 ...	19,408	7,105

The value of the metal production of the field to the end of the year 1916 is as follows:—

Gold	£27,998,617
Silver	109,427
Lead	55,587
Total	£28,163,631

* Calculated on value of £4 4s. $11\frac{5}{11}$d. per oz. fine gold.

GOLD PRODUCTION IN THE STATE OF QUEENSLAND TO THE END OF YEAR 1916.

Goldfield.	Total Production.	Percentage of Total Output of Queensland.
	Fine oz.	
Charters Towers (including Cape River) ..	6,591,477	34·41
Mount Morgan (including Rockhampton) ..	4,472,035	23·35
Gympie	3,274,797	17·09
Palmer	1,328,465	6·93
Ravenswood	863,312	4·56
Croydon	765,505	3·99
Etheridge, Oaks, and Woolgar	598,688	3·12
Hodgkinson	229,706	1·19
Other fields	1,027,513	5·36
State of Queensland	19,151,498	100·00

MINING.

Mining methods at Charters Towers do not differ in any striking manner from those employed on other Australian fields where inclined fissure veins are worked. Almost all the shafts except those located on the outcrops of the reefs are a combination of vertical and inclined, or underlie, shafts. They are, with scarcely any exceptions, always located on the lease boundary nearest the outcrop, so that the reef may be cut at the least possible depth. The underlies have obviated the use of crosscuts, but the great lengths of some of these in the deeper mines have increased the difficulty of securing adequate ventilation. The Brilliant reef, however, is so flat (averaging a dip of about 32

degrees) that it is doubtful whether the cost of artificial ventilation and the construction of airways into adjoining mines, as has been done, is not greater than the cost of the great length of crosscutting necessary from straight shafts. On the steeper dipping Day Dawn reef the New Brilliant Freeholds works with a straight shaft and crosscuts, and several short underlies, while Mills United has a combination shaft with an underlie about 2,000 ft. long. Overhand stoping is employed except in the flatter portions of the Brilliant and a few other reefs, where underhand stoping is carried down 10 ft. to 12 ft. from the levels. On portions of the very flat reefs the ore from the stopes has to be mechanically assisted to run to the levels below by iron troughing, but the varying size of the fissures and the frequency of loose "formation" on the hanging-wall precludes the general adoption of this plan, and shovelling is necessary, which is one of the items contributing to the high cost of mining.

Timbering the underground workings has been an exceptionally costly item, both on account of the loose granitic filling of the fissures which intervenes between the reefs and usually well-cleaved walls and necessitates extensive timbering, and the high price of mine timber, which had increased to 36s. per hundred super. feet in 1915. On the Day Dawn reef the altered diorite lying in the fissure causes dangerous scaling on the hanging wall, and all the mines on this line have had to use square sets, both in the underlies and the levels, except where the lode is small. In addition, slabbing or close-lacing are often necessary. In Mills United Mine, the lode opened to a width of 50 ft. in the No. 6 East level and necessitated the building of cribs or "pig-sties" to support the roof. This, however, was the greatest width of lode mined on the field. Heavy sets and close lacing are also necessary in most of the Brilliant Mines, where the lode is wide, as the altered grano-diorite is apt to come away. Where there is little water and the formation favourable, timbering has been dispensed with safely, as in the underlie of the Brilliant Deeps. There are also many instances where the reefs can be worked with props and breastplates only, as in the Victory Mine.

Ventilation in the deep mines has been one of the most acute problems latterly. The field has reached that stage where practically all the payable ore has been mined to a depth of 2,000 ft. on the Brilliant, Day Dawn, and associated reefs, and the trouble has been caused primarily by the inadequacy of the shafts, both in the number and size of the compartments, to ensure space for a sufficient passage of air to ventilate workings at the depths now attained, between 2,500 ft. and 3,000 ft. Three or four chambered

shafts, each chamber 3 ft. x 3 ft. 6 in., are mostly in use in mines whose workings exceed a depth of 2,000 ft. The Brilliant Deeps has probably suffered in this respect more than any of the mines, and an expensive connection with the workings of the Brilliant Block Mine, involving the sinking of an underlie shaft some hundreds of feet and a crosscut 700 ft. long had recently to be carried out to ventilate, more particularly, the workings of the "footwall" reef. The Brilliant Extended Mine secured ventilation for their deep workings by connecting the workings from No. 1 shaft to the No. 2 Bonnie Dundee shaft by a crosscut at a depth of 2,164 ft. The tendency of the reefs to split into hanging-wall and footwall sections and the number of small but payable branch reefs, both of which are characteristic of the field, have increased the difficulty of ventilating, more so as most of these have been followed down by separate underlie shafts, rather than by a system of crosscutting from a vertical shaft. As an instance of this, five separate "formations" or sections of the Day Dawn lode have been worked in Mills United.

Water in the majority of the mines has caused little trouble, but in some of them, notably the Brilliant Extended, where they bailed 1,548,338 gallons of water for the fortnight ending March 15th, 1916, the accumulated drainage from abandoned higher level mines has seriously hampered development in recent years. To deal with this, the field was early in 1916 declared a Mining Drainage Area and a Drainage Board formed. Evidently surface water caused trouble in some of the mines in the first few hundred feet, but there is very little percolation along the lodes in the deeper ground. Most of the water comes from occasional underground channels which are tapped, of which there are several in the Brilliant Deeps workings and one, which many years ago flooded out the Bonnie Dundee No. 2 shaft, was cut in a crosscut at a depth of 2,231 ft.

Practically no sampling, and very little sorting, of ore is resorted to on the field. The percentage of sulphides in the ore is a fairly safe indication as to the amount of gold contained and white quartz is generally regarded as barren, although some of the mine managers state that is not always the case. Where the reef is sufficiently large to work, and contains minerals, trial crushings of a few tons are taken out at irregular intervals depending on the appearance of the reef. With the exception, I believe, of only one mine—the Brilliant Extended—this course has been adopted, as mining men state values fluctuate so rapidly that sampling is rather unreliable, and the amount of mineral in the quartz is a rough guide. Sorting is usually only indulged in when the pyritous formation scales off the hanging-wall after

firing or breaking down. In several mines, ore which would itself show a slight profit over mining and extraction has to be left, because of the thickness of loose lodestuff superimposed over the reef. In the transport of material to the surface no storage bins are used underground for ore and mullock, and the ore is trucked and run on to the cages at the shaft.

The reefs have been extremely patchy, shoots of great richness alternating rapidly with zones of unpayable quartz. This has resulted in picking the best of the ore out and leaving the poorer grade. According to the statements of men on the field intimately knowing past and present mining practice, the averaging of ores appears, with but a few exceptions, to have been almost unknown. The high grade ore was usually all picked out and blocks of poorer grade, sometimes averaging 7 dwt. to 8 dwt. per ton, were left untouched, while the averaged ore would have paid handsomely and probably revealed further patches of high grade ore in amongst the poor, considering the fluctuating values of the reefs. Exceptional dividends were sometimes paid while the rich shoots lasted; for instance, the Queen Cross Mine paid from 1s. to 2s. per share monthly for several years on 200,000 shares paid up to 9s. per share, while the Victory Mine also paid royally when working the Brilliant shoot.

This policy has been carried out only at the ultimate cost of the life of the field. No reliable data can now be obtained as to the value and tonnage of ore left in the reefs, as so many mines are closed down and no records were kept. Trial crushings have furnished the managers in some instances with a rough basis and their statements usually put down values left at 5 dwt. to 12 dwt. of gold per ton. This ore usually carried a sprinkling of sulphides and there are probably many hundreds of thousands of tons that would average 7 dwt. to 8 dwt. With more reasonable mining and milling costs than existed in the past, a system of averaging ores and the devotion of more of the enormous profits, paid out of the rich shoots so liberally, to legitimate development work, there is little reason to doubt that the field would have still been enjoying a prosperous career.

TREATMENT OF ORE.

In the early days of the field the residues from the crushing mills were treated principally at the Towers Pyrites Works by the chlorination process. Prosperous days they apparently were for the company controlling those works when the Warden stated in 1878 that only 50 per cent. of the gold was being won in the milling of the ores, and yet the mill returns averaged 1½ oz. of

gold per ton. In later years a new plant and works costing £60,000 were erected on the side of Towers Hill by the manager (Mr. D. A. Brown), of which the chimney, so familiar to all who have been on the Towers, exists as a record of a vanished industry in North Queensland. With the advent of the cyanide process in 1892, the chlorination plant began to go under, and in 1899 it was converted into a cyanide plant. A brief description of the works is given by the manager in the annual report of the Queensland Mines Department for 1895, and a more detailed description is included in an article on the metallurgical methods of the field up to the year 1901, by Mr. Donald E. Clark, B.C.E. in "Australian Mining and Metallurgy."

The ores are amenable to ordinary amalgamation and the cyanide process. They consist of quartz with a varying percentage of sulphides, of which pyrite and galena are the most abundant, with zinc blende less frequent, as a rule, although it may in instances be the only mineral present. Mispickel and chalcopyrite are rarely present, and then only in small amounts. Usually the ore carrying the most sulphides, particularly galena, is the richest in gold. Massive sulphide ore from the Day Dawn P.C., containing 75 per cent. of sulphides, is recorded as averaging 10 oz. of gold per ton. At the present time the average of the ore being treated on the field would probably not contain more than 7 per cent. of sulphides, of which pyrite is the most abundant constituent.

The ores are crushed in ordinary stamp batteries or Huntingdon mills, and passed over amalgamating tables. In the case of the Companies the pulp is passed over one or two sets of Wilfley tables, and the concentrates therefrom are sold to representatives on the field of Australian smelting works after assay, while the slimes and sands are cyanided at the mills. In the case of tributers' parcels, concentration is not resorted to, but the pulp from the tables is further treated in amalgamating pans—Berdan and Wheeler pans used—and the residues are sold by tender to the owners of local cyanide plants, of which there are three or four operating outside of the mills.

During 1915 there were five mills crushing ores from the field, of which three were owned by mining companies, viz.—Brilliant Block, 40 head of stamps, Brilliant Extended Mill, 15 head of stamps and five Huntingdon mills, and the Burdekin Mill at Sellheim (jointly owned by Mills United and New Brilliant Freeholds) with 60 head of stamps. Two others, the Rainbow (22 head) and the Venus (35 head) crush ore from the other mines and tributers' parcels. All of these mills have grinding

Plate 5.

[*Photo., C. C. Morton and P. Harvey.*

No. 1—Rainbow Mill.

Towers Hill in background.

[*Photo., C. C. Morton and P. Harvey.*

No. 2—Brilliant Block Mill.

pans and Wilfley tables, and possess their own cyanide plants. The Brilliant Extended Mine possesses an up-to-date mill for it own ore, and the following description of the treatment there applies generally to the methods in vogue on the field.

The mill and cyanide plant is situated on the company's lease. The ore is brought from the shaft, a few hundred yards distant, by aerial tram. There are two Blake crushers, 20 x 12 and 14 x 8, the bigger blocks of ore going through both, while the smaller stuff goes only through the 14 x 8. The ore as fed to the mills and stamps ranges up to 3in. in diameter. It is carried up by elevator belts and then by carrier belts to the stamps and mills. At present only one shift is worked, crushing 50 to 75 tons a day, but full capacity of mill is 1,400 tons per week.

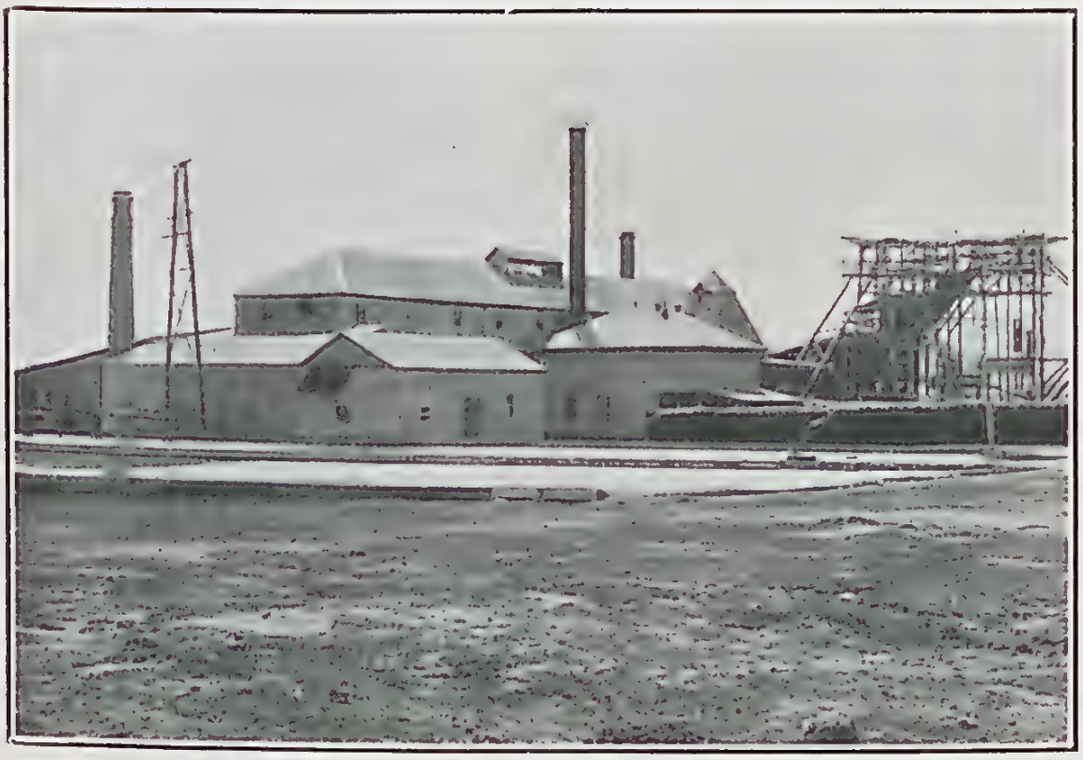
There are fifteen head of stamps of 1,200 lb. each and five Huntingdon mills, diameter 5 ft. From the amalgamating tables attached to these the pulp is passed over Wilfley tables, one to each head of stamps and each Huntingdon mill and the pulp from the whole of the tables is again passed over an extra table. The first concentrates average about 86 per cent. of pyrite and 13 per cent. of galena, and assay values are usually £25 to £30 per ton. The seconds average £18 to £20 per ton.

Assays of Concentrates.

	Firsts.	Seconds.
	oz. dwt. gr.	oz. dwt. gr.
Gold	7 11 0 ..	6 7 9
Silver	10 12 2 ..	9 0 0
Lead	11.6 per cent. ..	4.2 per cent.
Gold	6 8 0 ..	5 18 0
Silver	10 9 0 ..	9 0 0
Lead	10.3 per cent. ..	4.4 per cent.
Gold	5 2 18 ..	4 1 0
Silver	6 4 0 ..	5 7 0
Lead	8.8 per cent. ..	2.7 per cent.

These figures show with one exception a higher value in gold as the galena content increases, while analyses of raw ores quoted in this report show a similar ratio. A Pelton wheel is employed to convey the residues to a spitzkasten, where the sands are deposited, and the slimes go to the settling pits. These eventually go through a pan mixer in the ratio of two of sands to one of slimes for cyaniding. The assays of slimes average about 9 dwt. and sands, 2 dwt. 14 gr. The cyanide plant comprises five wooden vats, each of 110 tons capacity, and four iron vats of 220 tons. The residues are subjected to 0.2 K Cy solution for 24 hours, and then to a sump solution averaging a strength of 0.06 K Cy. for three to four days. For the period of six months ending 10th

Plate 6.



[*Photo., C. C. Morton and P. Harvey.*

No. 1—Brilliant Extended Mill.

[*Photo., C. C. Morton and P. Harvey.*

No. 2—Brilliant Extended Mill.

Side view, showing the Pelton Wheel.

November, 1914, the assays before cyaniding averaged 3 dwt. 9.7 gr. gold, after treatment 13 gr. giving an extraction of 2 dwt. 20·7 gr., equal to 12s. 1d. per ton. Cost of treatment was 4s. 4·5d. per ton, and the extraction averaged 84 per cent.

COST OF MINING AND MILLING.

Mining and milling costs have always been high, and only a field with the highest grade ores, such as Charters Towers, could have survived them for so long. They have been the subject of severe criticism by several mining engineers, in particular by Mr. Wm. Blane, of Johannesburg, who furnished a report on mining on this field at the request of the Queensland Government, and published in the annual report of the Mines Department for the year 1900, but whose remedial suggestions have never been followed.

The Brilliant Extended ranks as the most economically run mine on the field. Their working costs were reduced in 1909 to as low as £1 13s. 5d. per ton, which is probably the minimum ever attained on the field. The particular items were :—

	£	*s.*	*d.*
Mining	1	4	11
Milling	0	4	3
Cyaniding	0	3	9
Administration	0	0	5

Owing, however, to the since greater depth of stoping, the advanced price of fuel, mine timber, explosives, &c., their total advanced to £2 6s. 8d. for the last half-year of 1914, made up as follows: Mining 35s. 4d., milling 5s. 7d., cyaniding 4s. 4d., administration 1s. 4d. Under the head of mining, stoping cost 14s. 8d., and fuel 4s. 8d. per ton. For the half-year ending September, 1915, the Brilliant Deeps Limited costs were:—

	£	*s.*	*d.*
Mining and milling	3	7	1
Administration and workmen's insurance ..	0	2	6

These are both mines which have worked reefs considered as amongst the larger on the field. On the other hand, where the reefs are narrow, averaging between 6 in. and 12 in. thick, the mining costs alone are as high as £6 per ton. These are extremes, and the average for the field is somewhere near the mean of these figures.

In 1895 the average cost on the field of mining and treating a ton of ore was £2 14s. 9d., in 1915 it had reached £4 2s. The latter figure is accounted for largely by the fact that no big tonnages are now forthcoming, and that two of the principal

contributing mines were working narrow veins and mining costs were therefore inversely high. The drainage of water from high level mines to the deep level mines has recently increased the costs of working the latter owing to the excessive quantities to be bailed to prevent flooding.

Tonnage, Values, and Approximate Costs at Different Periods.

Year.	1895.	1905.	1910.	1915.
Tonnage milled	230,672	224,519	168,619	55,066
Values recovered	£784,284	£954,206	£623,891	£243,208
Profits	£153,039	£126,149	£53,269	£17,132
Value per ton of ore ..	£3 8s. 0d.	£4 5s. 5d.	£3 14s 1d.	£4 8s. 3d.
Profits per ton	£0 13s. 3d.	£0 11s. 8d.	£0 6s. 5d.	£0 6s. 3d.
Cost per ton	£2 14s. 9d.	£3 13s. 9d.	£3 7s. 8d.	£4 2s. 0d.

There are a number of contributory causes to the high costs that have always prevailed, which might come under the headings of: (1) local physical conditions, (2) general absence of methods for economic handling and transport underground, and (3) the high cost of fuel and mine timber.

The local conditions referred to are the great number of narrow branch reefs which have been exploited, necessitating considerable dead work to work them as well as the construction of separate underlie shafts, which, in turn, involve the use of extra numbers of air winches and two, and sometimes three, separate haulages to transport ore to the surface. Secondly, the flatness of the greater number of the reefs necessitating a large amount of shovelling in the stopes. Thirdly, the restricted thickness of the ore bodies and the presence of loose lodestuff between the quartz reefs and the walls, entailing a large expenditure in timbering the levels, shafts, and winzes. In regard to economic methods, in most of the mines trucks hauled in cages are preferred to skips for the transport of ore to surface and there is a total absence of storage bins underground for ore and waste, which in the large mines must have effected considerable saving with the acceleration of loading and automatic discharging in shafts of restricted size. This, of course, applied to those mines with big outputs and to the small outputs now being obtained has no application. Finally, wood is the only fuel used, and at present costs from 23s. to 25s. per cord according to length, representing a charge of from 4s. 6d. upwards—in extreme instances as high as 10s.—on every ton of ore raised.

A new log of wages for the field came into force on 1st March, 1916, resulting in a considerable increase generally, so that working costs in future will be further increased.

The cost of milling has always been abnormally high. It was formerly 14s. per ton at the custom mills, but is now 10s. to 11s. To this is to be added the cost of rail freight or cartage, varying from 1s. to 3s. per ton, according to distance, for with one exception none of the mills are situated near the mine shafts. Only four mines recently working have their own mills. The Brilliant Extended has shown what could be done in the way of revolutionising milling costs by reducing them as low as 4s. 3d. per ton in 1909, while in the past, mines such as the Brilliant P.C., Brilliant and St. George, and others with large outputs ahead of them, paid from 10s. to 14s. It appears that the proprietors of mills have, in some instances, been directors of mines, and were probably not averse to the shareholders paying excessively for milling while the custom mills were profiting by that policy.

LABOUR CONDITIONS

There has been for several years past a surplusage of skilled labour for the mines. As the mines closed down gradually a percentage of the miners left for other fields, but tributing and prospecting around Charters Towers have absorbed probably less than half of those thus thrown out of employment. The minimum wages ruling during 1915 for an eight-hour shift varied from 8s. 8d. to 10s. for ordinary miners, while machine men received 11s. 8d., engine-drivers 12s. 6d., and shift bosses 13s. 4d. Some of the miner prefer the chances of tributing, and many appear to easily exceed wages. As an instance, a tributer in Mills United Mine stated he had made £10 per week for over a year. A new log of wages came into force on the field on 1st March, 1916, in which considerable advances were made on the previous scale of wages.

The new schedule gives the wages as follows (for eight-hour shift) :—

	s.	*d.*		*s.*	*d.*
Machine men	13	0	to	16	0
Timber men	14	6	to	16	0
Brace and plat men ..	13	0	to	13	8
Truckers and mullockers	12	0	to	13	8
Engine-drivers	14	6	to	18	6

Chapter III.

PHYSIOGRAPHY.

Charters Towers stands on a peneplain elevated about 1,000 ft. above the level of the sea. The gently undulating surface of this plain, the sand-filled watercourses traversing it, and the isolated rock residuals (monadnocks) bespeak a topography of at least a moderately mature type. Following the railway line north-easterly from Charters Towers to the coastal range, a distance of 28 miles, the surface gradually depresses to the 780-ft. level at Macrossan, on the Burdekin River, a distance of 12 miles (fall 18·3 ft. per mile), rising to a height of 958 ft. at the Range (rise 11·1 ft. per mile) which forms the eastern edge of the peneplain. From this point the railway descends the Range, and the distance to Cardington, situated near the base of the foothills, is 10 miles in a direct line, and the decline in altitude is 618 ft. (fall 61·8 ft. per mile). The Range—only apparent as a range when viewed from the coastal side—is thus the line of demarcation between the coastal plain and the peneplain on which the goldfield is situated. Going westerly from Charters Towers, the surface is gently undulating, and rises gradually to an altitude of 1,318 ft. at Pentland, 60 miles away (rise 5 ft. per mile), beyond which it ascends more abruptly to the crest of the Main Divide, near Burra, 20 miles further west; and 1,819 ft. above sea-level. From the Main Divide it falls away gently to the western plains.

The dominant physiographic feature of the goldfield is Mount Leyshon and its surrounding hills, situated near the southern boundary, 17 miles from Charters Towers, and described by R. L. Jack.† These are stated to consist of volcanic rocks, porphyry, and greywackes, and the altitude of the highest peak is given as 1,900 ft. (aneroid reading) by Dr. Jack. There are no other residuals closely approaching this altitude on the field. Towers Hill, the culminating point of a group of grano-diorite hills situated within the environs of the city, is 1,370 ft. above sea-level, and 370 ft. about the peneplain level in the vicinity. It is, with the exception of Mount Leyshon, the most prominent monadnock, and is the more conspicuous by

† Report on the Gold Deposits of Mount Leyshon, by R. L. Jack. G.S.Q. Pub. No. 18. Brisbane, 1885.

Plate 7.

[*Photo., C. C. Morton.*

No. 1—Towers Hill, looking West.

A Grano-diorite Residual.

[*Photo., C. C. M. & P. H.*

No. 2—A Group of Grano-diorite Residuals.

Rule's Pinnacle to the right.

reason of its austere aspect, the surface being covered with large boulders, and it is almost devoid of vegetation. There are probably less than a dozen of smaller grano-diorite residuals scattered over the field, of which Rule's Pinnacle (1,300 ft). attains the greatest height. These are mostly boulder-strewn pinnacles, some being almost conical. Small isolated sandstone buttes of Tertiary (?) age are distributed irregularly over the peneplain, and attract notice by their red and brown coloration and mural walls, although they are dwarfed in altitude by the residuals of other rock formations. Little Red Bluff, 4 miles south-east of the city, is one of the most conspicuous of these, the flat top being 1,090 ft. above sea-level and about 60 ft. above the peneplain at the base, although it is slightly exceeded in height by a grano-diorite ridge about a quarter of a mile to

[*Photo., C. C. Morton.*

PLATE 8.—LITTLE RED BLUFF.

A Residual of Tertiary (?) Sandstone.

the north. The residuals known as "The Sisters" (1,210 ft.) and Lincoln's Hill (approximately 1,120 ft.) are the most prominent of those consisting of the metamorphic rocks. The former are composed mainly of quartzites and indurated schists. The diorite and schist areas to the west and north-west of the city stand well above the general level of the peneplain in rounded hills or ridges. Buckland's Hill (1,150 ft.), which overlooks the city from the west, is only exceeded in height in this area by a diorite hill immediately to the north-west which

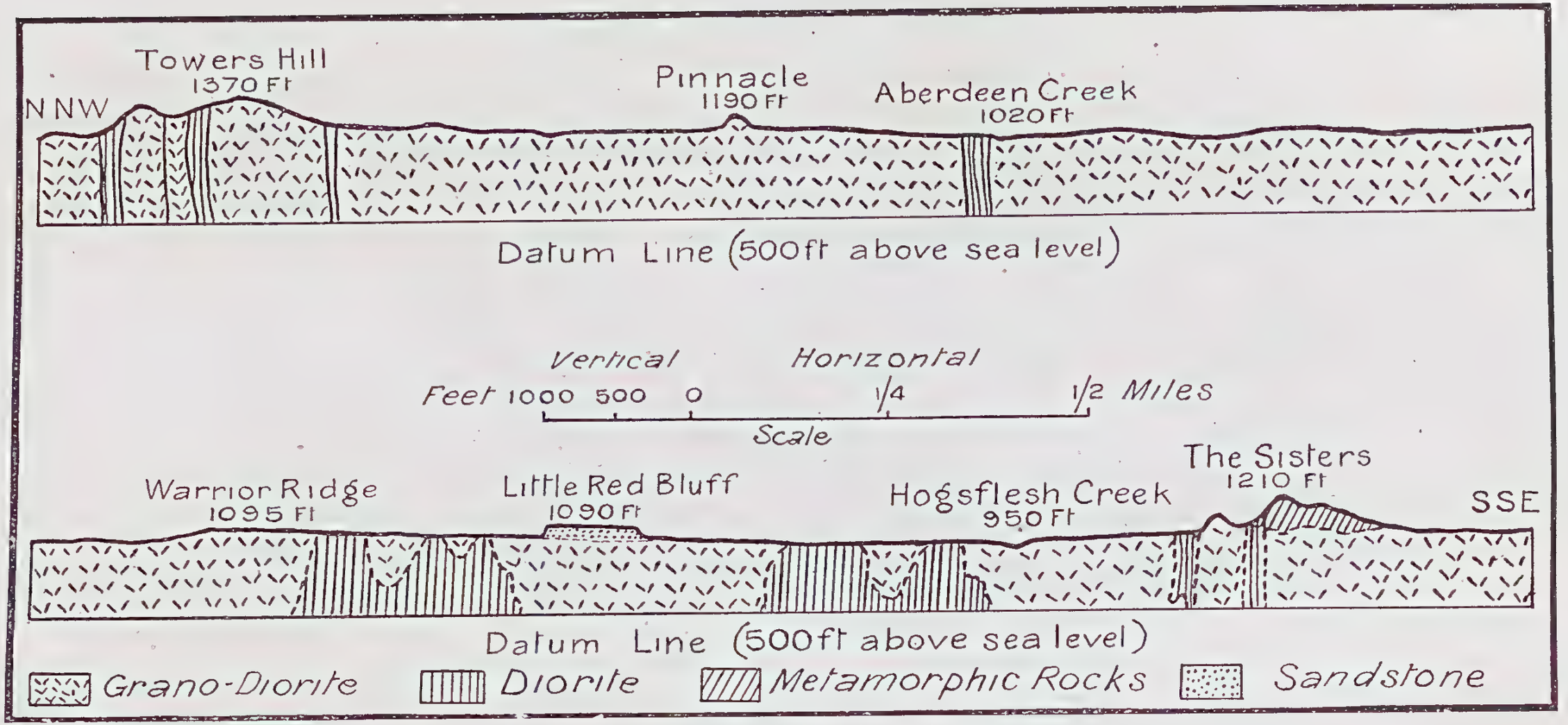


Plate 9.

CONTINUOUS SECTION SHOWING MATURE PROFILE OF CHARTERS TOWERS PENEPLAIN.
(Distance, 3¾ Miles.)

reaches an altitude of 1,160 ft. The section (Plate 9) illustrates on a small scale the actual surface relief over a portion of the field adjacent to the gold mines.

The goldfield is drained by the Burdekin River and a number of its tributaries, the most important being the Broughton River, which has only an occasional flow depending on the local rainfall. The Burdekin is one of the largest rivers on the eastern seaboard of Australia, both in volume of water carried and area of catchment. It does not possess the features of extreme maturity, pronounced meanders being absent as well as any extensive deposits of alluvium along its reaches. Occasional rapids are present, an example being those at "The Rocks," about 17 miles north-north-westerly of Charters Towers, and above the confluence of the Fletcher. There the river narrows to a gorge about 20 ft. wide, cutting through a flow of siliceous lava which is intensely hard.

Marks has noted the presence of these narrows or "rocky bars,"* and his paper is written with the purpose of showing that, although the Burdekin seemingly possesses the features of a mature stream, the gradient of the river below Macrossan to the edge of the peneplain, where it descends in falls to the coastal plain, and the number of "rocky bars" along its course, indicate a comparatively youthful type of river.

The Burdekin is a rejuvenated stream above the falls on the Coastal Range, this being presumably brought about by the late Tertiary uplift in common with the formation of the tablelands of South Queensland and New South Wales. Marks's evidence is drawn mainly from the river close to where it precipitates from the plateau to the coastal plain. It is in this region only that the rejuvenated river is actively accomplishing corrasion and eating its way back into the plateau. It is here that, as the work proceeds by headward recession, evidences of youth will appear. It is doubtful whether the evidence tendered would apply to the river above Macrossan, where there appears to be a diminution in the number of rapids, and where the stream is normally rather sluggish, and in places meanders in its sandy bed. The tributary watercourses which drain the goldfield have low banks often lined with narrow reaches of alluvium, and the majority only flow for a short period after heavy rain. The beds are choked with sand, so that little or no corrading of the channel bases is now being accomplished.

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* Notes on Portion of the Burdekin Valley. E. O. Marks (late Asst. Govt. Geologist). Proc. Roy. Soc. of Queensland, Vol. XXIV., p. 93.

The succession of events which has produced the present topography of this area appears to have been as follows:—

(1) A cycle of erosion in early or pre-Tertiary time forming a moderately mature peneplain at or near the sea-level.

(2) The inauguration of lacustrine conditions, possibly by slight subsidence or earth warping, and the deposition of freshwater sandstones and grits with clay bands in the depressions of this peneplain during Tertiary time.

(3) An uplift or series of uplifts resulting in an elevation of 700-1,000 ft. above sea-level in late or post-Tertiary time.

Unlike the somewhat similar tablelands of New South Wales which exhibit a mature topography dating from before the uplifts, the surface of the Charters Towers peneplain has been modified by the erosion of the Tertiary (?) sandstones which from their physical traits would rapidly disintegrate by weathering and corrasion.

Chapter IV.

GEOLOGY.

OUTLINE OF GENERAL GEOLOGY.

The oldest rocks exposed in the district consist of schists, quartzites, and altered limestone of pre-Devonian age. These are intruded by a batholith of grano-diorite, and both in turn are again intruded by an extensive series of igneous injections in the form of dykes or small bosses. Over parts of the field outliers of grit and sandstone of Tertiary (?) age lie flatly on the eroded surface of the grano-diorite. Within the grano-diorite two series of faults of different age have developed, forming the lode channels in which the auriferous ores have been deposited. These are of later age than any of the igneous injections, with possibly one exception—viz., the hornblende-porphyrite dykes. Subsequent to the time the fissuring occurred, other movements formed an intricate series of small faults distributed over the auriferous belt of country.

ROCKS OF SEDIMENTARY ORIGIN.

There are two system of rocks which come under this heading and can be classified as—

pre-Devonian:—Schists, slates, and phyllites.
Quartzites.
Altered limestone.

Tertiary (?):—Grits and sandstones with clay bands.

Pre-Devonian System.

DISTRIBUTION.

Within the environs of Charters Towers these rocks outcrop rather extensively to the west, north, and north-east. To the south they form an isolated range of hills about one mile in length known as The Sisters.

From personal observation they also appear to extend for a considerable distance to the west, all the country immediately to the west of Sandy Creek, near Charters Towers, being occupied by them. Dr. R. L. Jack has mapped in areas of metamorphic rocks along Sandy Creek as far north as the Burdekin River, and on the Upper Star River, and at several points on the coast range near Mount Frederick.* At Betts Creek, about 70 miles west of Charters Towers, schists and quartzites again occur on which beds of the Permo-Carboniferous system rest unconformably. The rocks of Betts Creek have much, lithologically, in common with those situated around Charters Towers,

* Map accompanying Report on Geology, &c., of District between Charters Towers and the Coast, by R. L. Jack F.G.S. Brisbane, 1879.

and their direction of strike and dip is approximately the same. There is very little doubt that all these occurrences belong to the one system, and that what was formerly a vast continuous area of probably ancient rocks has been divided into scattered areas by the agents of erosion.

CHARACTER.

The structural relations of the schists and quartzites in the field indicate a sedimentary origin; and the occurrence of andalusite, which seldom, if ever, occurs as a pyrogenetic mineral, accords with this evidence.

The rock formations show evidence of metamorphism by great thrust movement—*i.e.*, regional stress—which may have inaugurated the intrusion of the grano-diorite. This change is exemplified in the extremely fine lamination and schistosity as well as in the crystalline minerals produced in the schists. Although mica-schist is most common, andalusite-schists and chlorite-schists also occur, the former being found plentifully on the north-east side of Lincoln's Hill, while the latter occurs in proximity to the racecourse. Finely laminated phyllites and slates outcrop on the south-western side of Buckland's Hill.

Fresh fractures of mica-schist show the colour to be grey, but the oxidation of the iron of biotite has given them a characteristic reddish-brown colour in the field.

The quartzites are intensely hard, the dark varieties being well banded, and they form several prominent and rough ridges.

Plate 10.

BANDED QUARTZITE × 2.

THREE-QUARTERS OF A MILE WEST OF BUCKLAND'S HILL.

They also run in narrow bands of a few feet wide through the schists, and have, when light-coloured, been mistaken for felsite dykes.

Limestone, which occurs on the hill to the west of the Charters Towers Rifle Range and also near the Dalrymple Manure Reserve, is found in insignificant quantities only. It is bluish-grey in colour and entirely crystalline.

East of the racecourse the schist is of a different character to the rest of the field. It lies scattered in small patches on an eroded surface of grano-diorite which outcrops in all the stream courses. It seems that little more than a film of schist is left by weathering to cover the more elevated portions of the intrusion here. This area shows the contact with the grano-diorite

[*Photo., J. H. Reid.*

PLATE 11.—PRE-DEVONIAN SCHIST INTRUDED BY GRANO-DIORITE, IN BRANCH OF MOSMAN'S CREEK, NEAR RACECOURSE.

Altered Schist is dark, Grano-diorite light.

and, generally, the schist is extremely indurated and usually characterised by an abundance of brown chlorite. Near the north bank of Mosman's Creek and close to the line of contact, unassimilated boulders of schist up to 3- or 4 ft. in diameter lie entirely within the grano-diorite.

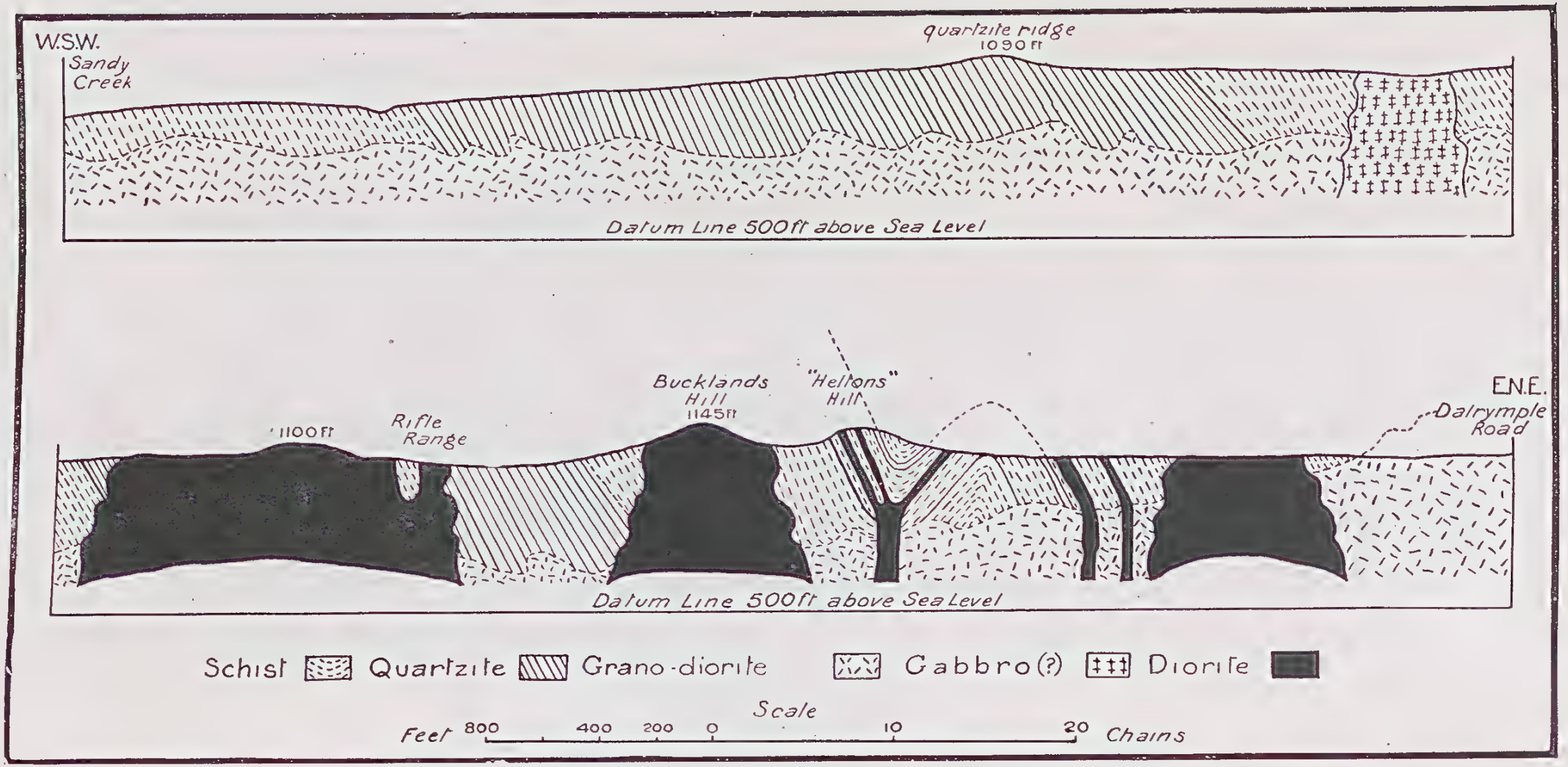


Plate 12.

GEOLOGICAL SECTION (DIAGRAMMATIC) FROM SANDY CREEK TO DALRYMPLE ROAD.
SHOWING RELATIONSHIP OF IGNEOUS INTRUSIVES AND METAMORPHIC SERIES.

The rocks of this system dip exclusively to the north-east at angles ranging from 45 degrees to 70 degrees, except to the east of Buckland's Hill, where the reverse dips indicate the formation of a small synclinal fold. The line of folding strikes on an average about 120 degrees east of north, but, followed to the north-west of the city, it swings more westerly.

Small lenticular bodies of white quartz were commonly observed within the schists, replacing them along foliation planes. Similarly occurring bodies of iron oxides were also noticed in two instances, but were of no economic significance on account of their small size. Although prospecting and a little mining have been carried on in schist country, notably around the Great Britain Mine to the north-west of the city, no payable ore-bodies or reefs have been discovered and likewise no economic contact deposits.

AGE.

Although careful search was made in what appeared likely looking slates, no fossils were found. Neither are there any rocks of systems, of known age, close to Charters Towers which furnish exact evidence as to their age. Dr. Jack, who, many years ago, prepared a map and report on the geology of the surrounding district,* had opportunities of studying their relations to rocks of other systems. He found that pebbles in conglomerates and sandstones of Devonian age consisted of these metamorphised rocks, and has thus called them pre-Devonian (Silurian). No further evidence was found by the writer to modify the term pre-Devonian.

They are also intruded by grano-diorite which is, on the authority of Dr. Jack, older than the Middle Devonian limestones of the Burdekin River. While they are now classified only as pre-Devonian it is possible to derive some broad inferences from comparison with the Lower Palaeozoic rocks in Australia. Compared with typical Silurian formations, limestones and slates are altogether deficient at Charters Towers, and the latter show a much greater degree of metamorphism than is usual. Nothing analogous to the carbonaceous slates and the volcanic tuffs of the Ordovician are present. In the degree of metamorphism, the apparently great thickness of the beds, and the great development of quartzites and schists, it seems more probable that they are at youngest of Cambrian age.

THICKNESS.

From Sandy Creek, on the western boundary of the geological map, to "Heltons" Hill (see Plate 12), the section

* R. L. Jack, *op. cit.*

shows a thickness of about 7,000 ft. The east side of "Helton's" Hill was the only locality observed in the area mapped where the beds dipped in the opposite direction. As all the dips observed in the southern part of the field were in the prevailing direction—*i.e.*, north-east—it is suggestive of a much greater thickness for the entire series. To the west, and outside of the area mapped, the beds still dip that way without any reverse dips, indicating repetition of the same beds by small folds, and it is probable that the series is of great thickness, in all likelihood many thousands of feet more than that measured in the above section.

Tertiary (?) System.

General.

Two small outliers of a sandstone formation of comparatively recent geological age occur on the Millchester rifle range and at the Little Red Bluff respectively. These form small flat-topped buttes resting on grano-diorite, and are conspicuous by their reddish colour and mural walls. Looking west from Charters Towers, areas of the same formation form an even skyline on the horizon as far as the eye can see. Numerous outliers occur scattered over the goldfield, and these have been mapped in by Marks, who has referred to them as aluminous sandstones.† As stated by that writer, there is little doubt that they have been derived from the weathering of the underlying grano-diorite. Probably the term argillaceous would be more appropriate than aluminous in referring to the sandstone, as, according to the analyses published by Marks, free alumina was not present in any appreciable quantity, while the percentage of "combined" silica was more than sufficient to satisfy the total alumina.

The samples analysed were from Charters Towers, and I quote the analyses given—‡

	No. 1.	No. 2.
Ferric oxide	8·6 per cent.	4·0 per cent.
Alumina	22·7 „	21·1 „
Silica	59·6 „	65·6 „
	90·9 „	90·7 „

(Analyst: F. E. Connah, F.I.C.)

Dr. Jack, in his report on the district previously quoted, has described these beds and has mapped in areas of the same formation to the east of Rishton on the Burdekin River, and also on the Keelbottom River, 20- to 30 miles north of Charters

† Outside Mines of Charters Towers, by E. O. Marks, Q.G.S. Pub. No. 238. Brisbane, 1913.

‡ *Op. cit.*, p. 10.

Towers. Similar beds occur between Pentlands and Betts Creek, about 70 miles west of Charters Towers, and at the latter place they lie unconformably on Permo-Carboniferous strata. A great portion of the area of the Cape River Goldfield mapped in on the geological map of the State as alluvium is certainly identical with this formation, as noted by Marks. In a report on the Glossopteris beds of Betts Creek I tentatively placed them as of post-Cretaceous (?) age.*

DESCRIPTION OF THE BEDS.

An area of about 12 miles south-west of Charters Towers was also examined, and the beds appear to be identical with those near Millchester and at the Little Red Bluff. The beds are roughly stratified in places and appear horizontally bedded. They lie on a gently undulating surface of grano-diorite and are flat-topped with almost vertical escarpments halfway to base, the lower half being occupied by talus slopes. The individual beds vary in composition, some being an ochreous sandy clay, but the prevailing rock is a felspathic and ferruginous sandstone or grit, the quartz grains being usually sub-angular. A careful search revealed no plant or animal remains. The thickness of the beds in the district does not anywhere appear to much exceed 100 ft. The top of Little Red Bluff stands 60 ft. above the grano-diorite floor on which it rests, but within half a mile to the north a ridge of grano-diorite reaches a few feet higher in altitude.

AGE AND CONDITIONS OF DEPOSITION.

Dr. Jack considered the formation of the coastal plain and the sandstone and grits of the plateau as belonging to the one system, and referred them to post-Tertiary age mainly on evidence from the coastal plain, near Townsville, where he found a species of *Unio,* identical with a present-day form, and what was apparently a human implement.

In the light of more recent work, particularly in physiography, there appears to be sufficient reason for revising this classification on the following grounds:—

There is a difference of elevation between the two formations of nearly 1,000 ft., and we have no evidence of a movement to account for so great a difference, subsequent to late Pliocene or early Pleistocene age. In this connection E. C. Andrews states " the great uplift which closed the Tertiary isolated the

* Q.G.S. Pub. No. 254.

coast from the interior."* The age of the plateau beds is older than this uplift. The almost dead level of the coastal plain reaching inland from Townsville suggests a plain of sedimentation recently uplifted slightly. Of such an uplift there is abundant evidence along the whole of the eastern coast of Australia in the raised sea-beaches and marine shells found on the coastal platforms. The disintegration of the plateau formation into small isolated buttes appears more feasible for a Tertiary age, for, as pointed out in the chapter on Physiography, stream corrasion on the plateau was probably slight, although the sandstones and grits have inherent weaknesses exposing them to rapid denudation by weathering. This has so far advanced that it favours a greater age than post-Tertiary. There are certain lithological differences between the two formations—*e.g.*, there is an entire absence of conglomerates and breccias from that of the plateau, and there are no red beds in the coastal formation.

On the right bank of the Burdekin River, below Rishton and situated about 16 miles east of Charters Towers, Dr. Jack records that Mr. T. Buckland discovered some fossil wood and portion of the lower jaw of a marsupial identified as *Diprotodon Australis*† in grit similar to that around Charters Towers. There can be no doubt that these belong to the same formation, for the intervening peneplain is dotted at intervals with outliers of the red sandstones and grits. These fossils therefore indicate a freshwater origin for the beds, and preclude any age earlier than Tertiary to which they can be provisionally referred at present.

In considering the conditions of deposition, the altitude and lithology of the beds furnish some evidence. It is noticeable that the highest areas in the district are occupied by granodiorite and metamorphic rocks, while the sandstone is often lower in elevation than adjacent small rises of other formations. This is interpreted as meaning that these beds were not deposited over a continuous area, but rather in a lake, or a series of lakes in depressions, for the topography of the plateau is one of moderate maturity, as it was apparently before the uplift, and erosive activities have since been comparatively dormant on the plateau while the coastal streams have been working back through the Range by headward recession. Thus it is unlikely that these sandstones would be completely removed from all the higher elevations since Tertiary time while the streams were comparatively inactive. The sediments, which are composed of granitic débris, are scarcely stratified beyond the bands

* E. C. Andrews. Geographical Unity of Eastern Australia. Jour. Roy. Soc. N.S.W., Vol. XLIV., p. 428.

† R. L. Jack, *op. cit.*, p. 7.

of ochreous clay, and the quartz grains of the sandstones and grit are generally angular enough to suggest very little transportation. That they were deposited under shallow water conditions is attested by the little variation in the character of the sediments, the coarser quartz grit being freely mixed with fine quartz grains and felspathic material.

The ideal conditions for such a deposit appear to have been the formation of a lake system, on a surface of moderate relief, by such slow subsidence that the filling of the lakes with detritus never permitted any depth of water to form.

AURIFEROUS LEADS.

Beneath several of the sandstone buttes, notably at the Little Red Bluff and near Millchester, are shallow leads on which a great number of shallow shafts and potholes were sunk prior to the year 1880. The lead material at Little Red Bluff consists of clay silt and granite detritus, and has been followed along a narrow channel for about 30 chains. There cannot be any great depth of it considering the conformation of the grano-diorite surface, probably not more than 30 ft. A similar lead has been worked near the Warrior reef a little to the west.

As regards the occurrence of gold in these leads, Dr. Jack in his report, already quoted, states:—

"The 'drift' of the Little Red Bluff, and of the deep lead in connection with it, has been tried again and again for gold. Quite a rush to it took place about two years ago (1876 or 1877), but without much success."

Again—

"The deep lead to the south-east of Millchester employed the energies of a large number of diggers on the first rush to the new field in 1872, when a good many made considerable hauls. This lead has more conspicuously 'paid' than any other alluvial workings on the field."

The origin of these leads is considered to be due to the gradually filling of old stream channels with detritus from the

FIG. 1.—SECTION ACROSS LITTLE RED BLUFF.

Plate 13.

[*Photo., C. C. Morton.*

LITTLE RED BLUFF.

An Outlier of Tertiary (?) Sandstone (Northerly Aspect).

grano-diorite during the slight and very slow subsidence which gradually introduced lacustrine conditions, resulting in the covering of the low-lying portions of the peneplain with the sandstones which lie immediately over the leads. There are no coarse gravels in these channels, and the streams were evidently too sluggish to more than roughly grade the débris which was washed in from the neighbouring slopes and choked up the watercourses. This would account for the general poverty of the leads, for natural concentration of the gold was not brought about to any extent.

IGNEOUS ROCKS.

It is proposed to state here little more than a list of the igneous rocks, arranged as far as possible in chronological order, as the following chapter has been devoted to a separate account of them.

There is a rather extensive series of intrusions on the field, but volcanic rocks are absent around Charters Towers, the nearest being flows of basaltic lava on the Burdekin River, about 15 miles distant in a north-west direction. The intrusives have been arranged in their order of sequence as far as possible by their field relations to one another. Definite ages cannot be assigned to them owing to total lack of evidence, and it can only be said that probably between Lower Devonian and Tertiary times, and following on a huge intrusion of grano-diorite, there was a series of small intrusions ranging in composition from siliceous to sub-siliceous types.

Chronological Sequence.

Pre-Devonian Schists and Quartzites—

Grano-diorite (Lower Devonian or pre-Devonian).
Quartz porphyry.
Diorite ("Warrior").
(?) Aplitic granite and dykes ("felsite").
(?) Gabbro.
Diorite ("Buckland's Hill") and dykes.
Diorite-porphyrite dykes (older series).
Diorite-porphyrite dykes (younger series).

Reef Fissures—

(?) Hornblende-porphyrite dykes.

Tertiary (?) Sandstones and Grits.

It is not known whether the aplitic granite precedes the gabbro or *vice versâ*, and similarly the reef fissures or the horn-

blende-porphyrite dykes. Elsewhere it is noted that Dr. Jack describes one of the reefs being cut by a porphyrite dyke, which is almost certainly the hornblende-porphyrite, since it outcrops at the surface in the locality mentioned and the strike agrees with Dr. Jack's observations.

STRUCTURAL FEATURES OF THE FIELD.

The Charters Towers district is mainly an eroded area of grano-diorite on which residuals of pre-Devonian rocks and Tertiary (?) sandstone rest, all of which, except the last-mentioned, have been folded or faulted.

Folding.

The pre-Devonian sediments are strongly folded and metamorphosed. All traces of bedding planes have been obliterated, and a high degree of schistosity developed in what were originally great thicknesses of clay shales in their conversion to mica-, andalusite-, and chloritoid-schists. That this was a regional movement of considerable or great extent is evidenced by the similar attitude and metamorphism of the schists at the Cape River Goldfield, 70 miles to the west. This movement occurred before Devonian time for the Middle Devonian limestones of the Burdekin River in the north of the district have not suffered noticeable metamorphism and are only moderately folded. The thrust may have occurred as a preliminary movement of the crust prior to the intrusion of the great batholith of grano-diorite for this rock formation, though much more resistant in its nature, does not show evidence of great stress. Sections of it, under the microscope, do exhibit stress phenomena but it must be remembered that around the fissures of Charters Towers there were probably conditions of local intensity of stress only, when more recent faulting occurred. There is then on this field evidence of only one great tangential thrust, and this occurred prior to the Devonian and probably later than Cambrian time. The axis of folding lies in a direction about 120 degrees east of north, but following it to the north-west, within the environs of Charters Towers, it swings more to the west. This may, however, be a local variation only, due to the later diorite intrusions with which the schist in that quarter is riddled. The schists and associated rocks have steep dips varying from 45 degrees to 70 degrees from the horizon. East of Buckland's Hill the prevailing dip (north-east) is reversed and a small syncline has been formed there, but west of that the Charters Towers rocks form the eastern limb of an anticline of great dimensions.

Faulting.

Three systems of faults can be identified on the field. In order of sequence they are north-south faults mostly hading east, east-west faults mostly hading north, and a series of very

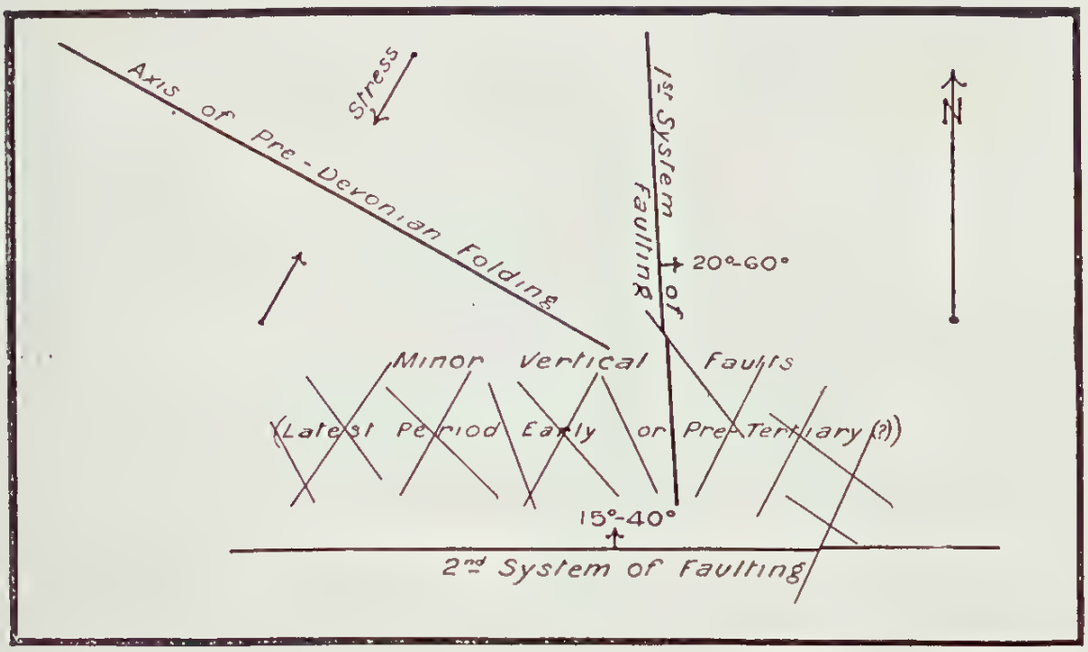


Fig. 2.—Diagram Showing Folding and Faulting Systems on the Field.

small faults, mostly vertical, which can only be traced in the mine workings or in the faulting of igneous dykes at the surface, and which follow no definite direction in trend. These latter are abundant over at least that part of the field where the main auriferous deposits existed. In addition, there are several important faults known which cannot be definitely correlated with any of the above systems, their strike being transverse to, and their age later than, the two earlier systems of faults. These comprise the Caledonia fault and the faults in the Bonnie Dundee, Brilliant Central, and Brilliant Extended mines. The Caledonia is a normal fault, striking approximately north-east to south-west, and hading to the south-east at an angle of about 70 degrees. It passes through the workings of the Caledonia and the Victoria and Queen mines, where the reefs were thrown down on the eastern side a further depth of about 90 ft. The Bonnie Dundee and the Brilliant Central faults are known to displace the east-west faults. The larger fault fissures have proved to exceed a depth of 3,000 ft. and to extend to distances exceeding a mile. It is in the fissures produced by the first two systems of faulting, particularly in the east-west faults, that the auriferous reefs of the field have formed. Both systems hade at a low angle

with the horizontal plane, and although angles range from 15 degrees to 65 degrees the average is nearer 35 degrees. The comparative flatness of some of these fault fissures and the appearance of slickensided walls, would certainly indicate that they were of the nature of overthrusts, but the evidence of the movement of the igneous dykes, which have all been dislocated by these faults, show that the ultimate movement was in the direction produced by normal or gravity faulting.

The movements along these fault fissures were small. Two series of dykes have been cut and the lateral displacements of these measured from two to fifteen feet. The direction of the movement must be known to calculate the amount of movement. If the movement was horizontal (which would be the minimum possible) the distance between the faulted dykes would be a

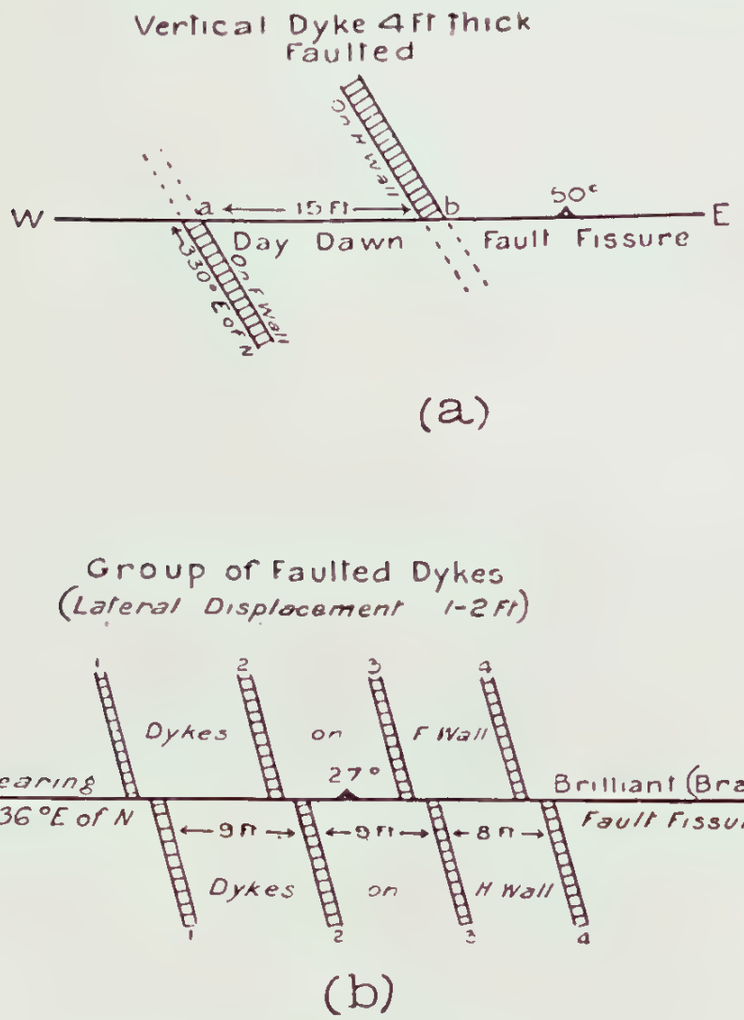


Fig. 3.—Plans of Faulted Dykes.

(*a*) *Pfeiffer's Mine, No. 3 West level.*

(*b*) *New Brilliant Freehold Mine, No. 8 West level.*

measure of the movement, and along the same fault would be nearly equal in every case apart from considerations such as the angle of intersection of the dyke and fault, and the

angles of dip of each. This is not the case, showing that the movement was not entirely horizontal. The striations on the fissure walls indicate at all events that the final movement was in a vertical direction. Assuming that the movement was entirely in a vertical direction, which would represent the maximum possible in considering these faulted dykes showing lateral displacement, the total amount of movement can be calculated by the solution of two triangles when the angle of intersection of dykes and fault plane, the hade of fault and the dip of dykes, and the amount of lateral displacement are known. For the faulting of dyke in Figure 3A the displacement along the dip of the fault plane is calculated at 40 ft. and the down-

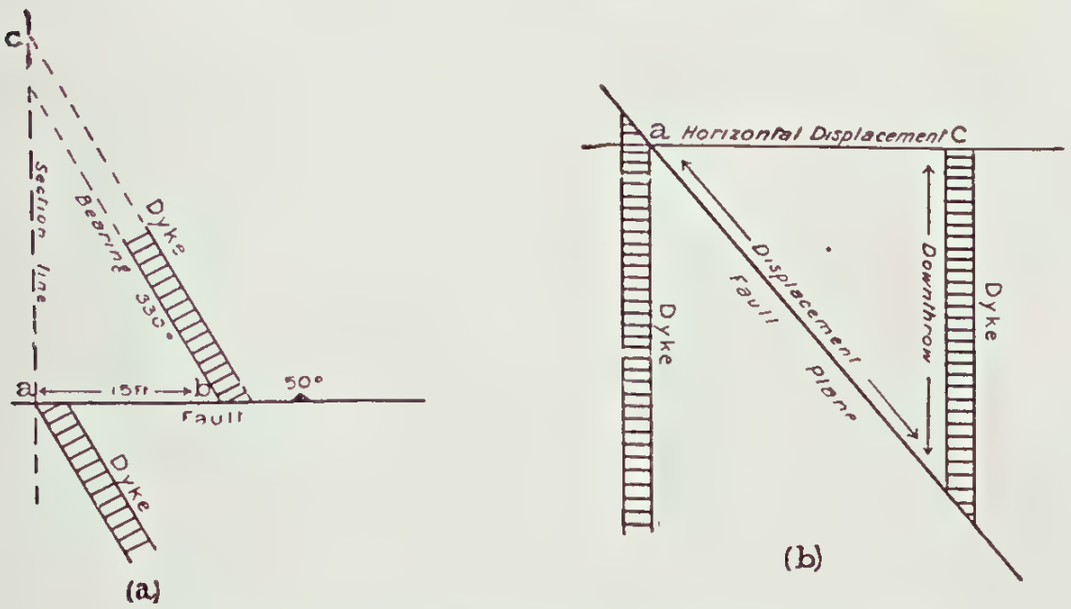


FIG. 4.—PLAN (*a*) AND SECTION (*b*) OF FAULTED DYKE IN FIG. 3A. Showing possible vertical (maximum) movement.

throw at 25 ft. (Fig. 4). In the dykes (Fig 3B) the possible maximum movement was not more than 3 ft. to 4 ft. As there are two series of dykes which intersect each other almost at right angles, and both series are faulted, it is possible to show that the movements in the north-south and east-west fault fissures while varying in degree were not considerable, ranging from several feet to a possible maximum of about 40 ft. in the case of the Day Dawn, but probably considerably less than that figure. The vertical profile of these fault fissures, showing striking curves and bulges, offers objections to an extensive vertical movement, and the difference in lateral displacement of dykes by the same fault proves it was not horizontal only.

It is suggested that the three systems of faulting occurred at close intervals, as the nature of the filling of the fissures is in many cases similar. Some of the small faults, although never worked as reefs, contain veins of quartz with sulphides of lead,

iron, and zinc, resembling the ores contained in the lode fissures. An example of this is a vertical fault which displaces the Brilliant reef in the Brilliant Central Mine, at the junction of the No. 7 west level with the No. 2 underlie shaft. It carries several inches of mineralised quartz similar to the ores worked, and it was stated by the mine manager to carry gold. In other cases these faults only show as breaks in the country rock with several inches of broken grano-diorite and "pug," as exemplified in the small faults in Clark's Gold Mine.

The small faults are in evidence in the western end of the railway cutting near Rainbow road, where the diorite-porphyrite dykes are frequently displaced, and there are also examples in the Victory and Worcester Mines. Most of the plans of the old mines in the Queenton area show a considerable number of faults without any noticeable dislocation of the reefs. It is practically impossible to trace these faults in adjoining mines as they are small and numerous.

The paucity of information regarding faulting on the field is to be ascribed chiefly to the few opportunities of studying these faults except on mine plans. However important the small faults may be as regards the origin of the gold ores, the evidence of which is considered in the chapter on the genesis of the ores, the field has been almost free from movements producing faulting on a large scale, since the formation of the lode fissures.

All that can be stated as to the age of faulting is that it is almost certainly pre-Tertiary, on the ground that the auriferous leads lie under the sandstone and grits, provisionally referred to the Tertiary period, and the source of the alluvial gold must have been the quartz reefs in the fault fissures.

Summary of Geological History.

The earliest rock system—the metamorphic series—was apparently formed in Lower Paleozoic time when a great thickness of sandstone and shales was deposited. The total absence of conglomerates—and practically of limestones—indicates non-littoral conditions, and it was evidently part of a large area of great, but slow, subsidence. This may have been during the Cambrian period but before the Devonian these beds were upheaved above sealevel and folded, crushed and converted into their present crystalline condition. From the magnitude of the area covered by the grano-diorite this movement may have been initiated by the intrusion of this batholith which came before, or in, Lower Devonian time. The next record is the deposition of coralline limestones, sandstones, and conglomerates of the

Middle Devonian age lying on the eroded surfaces of the granodiorite and metamorphic series, pebbles of the latter having been recorded in the conglomerates. The Devonian rocks are found on the north bank of the Burdekin river within ten miles of Charters Towers. A later uplift is necessary to account for their present position and attitude but this and all subsequent movements must have been slight compared to the intensity of the pre-Devonian earth movements.

While there is no record of Permo-carboniferous rocks in the district, marine and freshwater beds were being deposited in the Bowen area and freshwater beds at Stewart's Creek on the east and at Betts Creek on the west, so that the region must have been one of low relief. Apparently between Devonian and Tertiary time there was a sequence of small igneous intrusions. Many of these, if not all, may have been syngenetic, their differences in chemical composition being possible by differentiation of the magma between separate episodes of intrusion. The majority are of a dioritic facies. Of their exact age no data has been found.

Of the Mesozoic era there is no local record.

In Tertiary time the area appears to have been an eroded surface at a low altitude in which slight subsidences formed an area of inland drainage followed by the formation of shallow lakes where sandstones were deposited containing remains of mammals and wood. At the end of the Tertiary period there is evidence of a vertical uplift along the eastern seaboard of Australia, and this area was elevated at least 1,000 feet above sea level. Since then the coastal rivers have been attacking the plateau on its eastern flank, and to-day it is probable that this land surface at 1,000 feet elevation has a somewhat similar maturity of topography to that which existed on the Tertiary peneplain near sea-level, but modified by the dissection of areas of Tertiary (?) sandstone.

Chapter V.

PETROLOGY OF THE IGNEOUS ROCKS.

Introductory.

No detailed description of Charters Towers rocks as a whole has previously been published. The nomenclature of different rock types on the old geological map appears to have been based on megascopic descriptions of field specimens. Microscopic descriptions of some types have been given by Clarke in petrographical notes from Queensland.* To supply the want of a systematic account of the igneous rocks of the field this chapter is intended. For that purpose over 100 specimens of the igneous rocks were collected and about forty of the most representative, and those presenting special features such as differentiates of individual intrusions, were sectioned and examined under the microscope. From two to eight sections of each rock type were examined so that a generalized account of each intrusive might be achieved rather than only descriptions of individual specimens.

The metamorphosed sedimentary rocks have not been included in this examination, as they have no bearing or influence whatever on the auriferous reefs and the economic aspect of this report has been considered paramount. General descriptions of them are included in the previous chapter, as well as the sequence of the igneous rocks hereafter described.

GRANO-DIORITE.

This is the most extensively developed rock type on the field, and is the enclosing rock of the gold reefs. It is locally referred to as granite, as in hand specimens it is inseparable from a normal biotite-granite. In his report on Charters Towers† Dr. R. L. Jack says it best deserves the name of syenite, but later refers to the occurrence of both syenite and

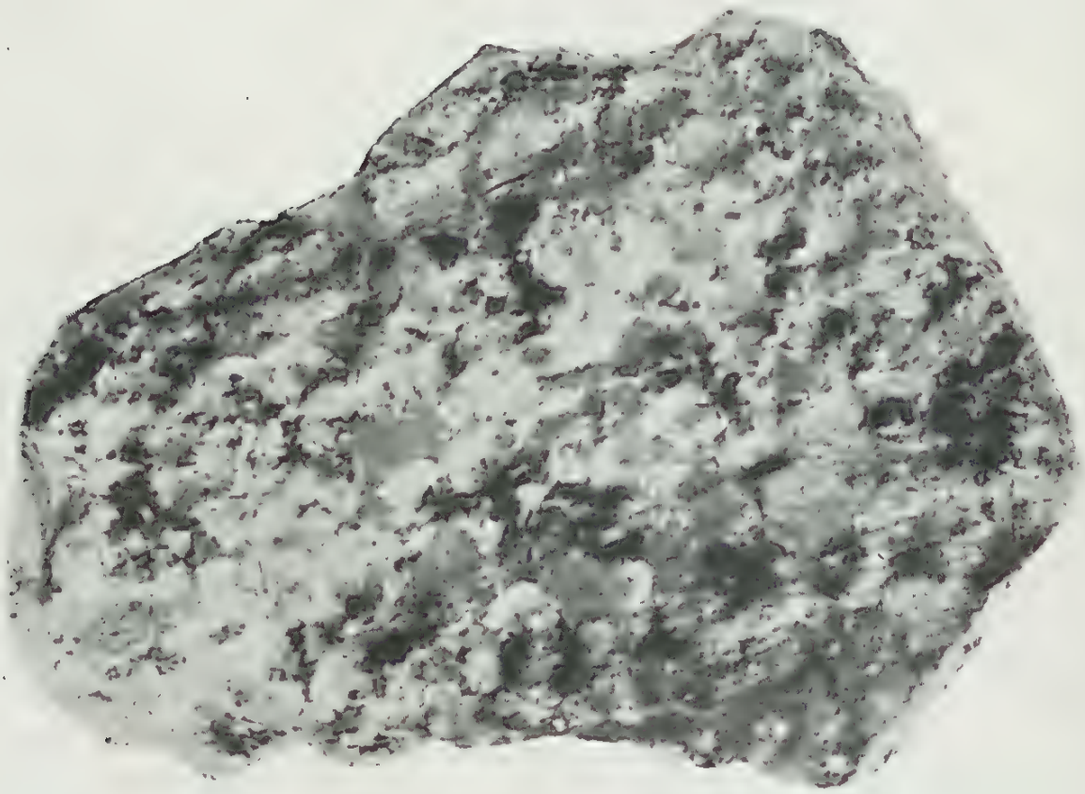
* Geol. Pal. of Queensland. Brisbane, 1892. G. S. Pub. No. 92, pp. 700–736.

† R. L. Jack, *op. cit.*

granite. It is shewn on the former geological map as granite. It is only in thin sections that the alkali-felspar is seen to be so subordinate to a plagioclase that, according to the mode classification now adopted, it must be referred to the grano-diorites. The analyses of the rock offer confirmation of the microscopic examinations in the relatively small percentage of potash to the soda and lime present. In places the rock, as noted by A. Gibb Maitland, passes gradually, with a decrease of alkali-felspar and quartz, and an increase of hornblende as the ferro-magnesian constituent, into quartz-diorite, and finally to an almost normal coarse diorite with but little interstitial quartz, which is only to be seen under the microscope. Two areas where this type may be noted are on the Townsville Road, a quarter of a mile east of the Queenton State School, and on the mullock heaps along the outcrop of the Lord Stanley reef on the Black Jack Road. In the former case the outcrop extended over a few acres, but no contact could be traced in the adjoining creeks, and the transition to normal country rock appears gradual. In the latter case no outcrop was seen, but specimens were obtained from the No. 5 level in the Lady Maria workings near at hand. No sharp change in the two different types, in this instance, was noticed, and there is little doubt that the quartz-diorites are the result of magmatic differentiation *in situ*. Compared with the territory occupied by the normal rock, these occurrences are insignificant, but their origin explains the changes which may be noticed in different parts of the field. East of Gladstone Creek the country rock appears less siliceous than the normal grano-diorite.

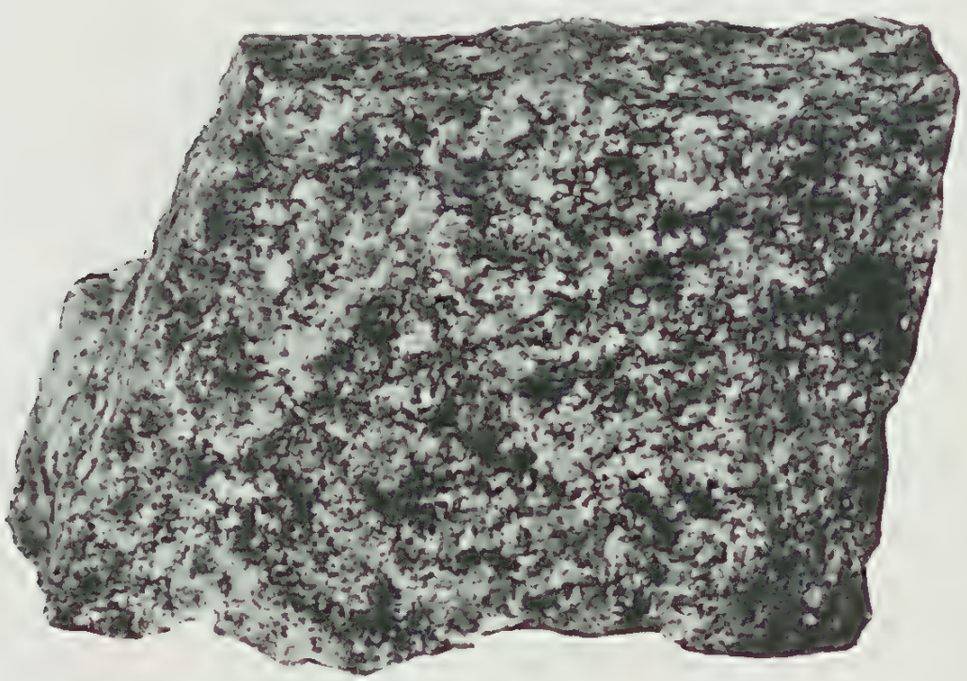
The prevailing colour of the grano-diorite is light-grey, and the texture is moderately even, medium grained and non-porphyritic. The plagioclase felspars are white or light grey, and orthoclase of a faint pink shade can be seen sparingly in hand specimens. The rock alters to a red colour along the fissures and in contact with dykes at the surface. The less siliceous differentiates are dark grey or almost black in appearance, and range from coarse to fine in grain, although never aphanitic, Small dark-coloured segregations, up to six inches in diameter, and containing hornblende, are common all over the field.

Plate 14.



[Photo., A. B. Walkom.

No. 1—Grano-diorite (X2), St. George and Moonstone Shaft (No. 43).
Dense Black = Biotite. White = Felspar. Smoke-grey = Quartz.



No. 2—Quartz Diorite (natural size), near Townsville Road.

In the following table of analyses, Nos. I.-III. are of the Charters Towers rock while Nos. IV.-VII. are of grano-diorites from Victoria and New South Wales, included for comparison:—

—	I.	II.	III.	IV.	V.	VI.	VII.
SiO_2	71·58	66·18	63·20	68·92	63·38	65·59	58·93
Al_2O_3	15·04	17·01	}	15·26	17·36	17·46	17·48
Fe_2O_3	0·97	1·60	}23·05	0·80	1·61	4·21	1·73
FeO	1·66	2·74	}	3·30	1·98	0·10	5·01
MgO	0·90	1·82	0·71	1·64	1·80	2·35	4·33
CaO	2·52	4·70	4·95	3·04	4·18	1·03	7·08
Na_2O	3·83	3·06	5·77	2·71	4·07	4·10	2·91
K_2O	3·12	1·66	2·03	2·93	0·31	2·89	1·34
H_2O+ ..	0·20	0·58	..	1·04	0·54	1·98	0·73
H_2O- ..	0·15	0·08	..	0·22	..	..	0·13
CO_2	trace	trace	..	nil	1·13	..	..
TiO_2	0·16	0·26	..	0·70	..	..	0·52
P_2O_5	0·13	0·17	..	0·19	..	..	0·14
S (as FeS_2) ..	0·02	0·02	..	nil	..	..	..
MnO	0·03	0·07	..	trace	..	..	trace
F	nil	nil	..	..	..	..	..
FeS	..	..	..	..	3·38	..	..
Loss on ignition	..	..	0·95	..	..	..	..
	100·31	99·95	100·66	100·75	99·74	99·71	100·33

I. Charters Towers, New Queen Central Mine. Analyst, F. E. Connah, F.I.C.
II. Charters Towers, East Mexican Mine. Analyst, F. E. Connah, F.I.C.
III. Charters Towers, Ruby Mine. Analyst, H. T. McGillivray, M.A.
IV. Grano-diorite, Macedon, Victoria. *Ref.*, Bull, G. S. Vict. No. 24., p. 20.
V. Grano-diorite, Dandenong, Victoria. *Ref.*, Proc. Roy. Soc. Vict., Vol. XVII., pt. I.
VI. Grano-diorite, Omeo, Victoria. *Ref.*, Proc. Roy. Soc. Vict., Vol. XIV., p. 201.
VII. Grano-diorite, Wyalong, New South Wales. *Ref.*, Min. Res. No. 5, Geol. Sur N.S.W., p. 14

The norms of the Charters Towers grano-diorite calculated from analyses I. and II. are as follows:—

—	I.	II.
Quartz	30·48	28·50
Orthoclase	18·35	9·45
Albite	31·96	25·68
Anorthite	11·68	22·52
Hypersthene	4·18	7·80
Ilmenite	0·30	0·46
Magnetite	1·39	2·32
Corundum	1·12	2·04
Apatite	0·34	0·34
	99·80	99·11
Water	0·35	0·64
Manganous oxide	0·03	0·07
Total	100·18	99·82

The mode of the Charters Towers rock has been determined approximately by Rosiwal traverses of two micro-sections of different specimens. The results are tabulated in the following tables.

In the case of plagioclase the specific gravity was obtained from tables after its determination by the Michel-Lévy method. For the other minerals no determinations were made.

CALCULATED MINERAL COMPOSITION (APPROXIMATE) OF GRANO-DIORITE.

(1) NEW QUEEN CENTRAL MINE.*

Minerals.	Total Diameters.	Percentage Volume.	Specific Gravity.	Gravimetric Proportions.	Mineral Percentage.
Quartz	2,590	34·70	2·65	91·95	33·98
Orthoclase ..	1,178	15·79	2·55	40·26	14·88
Plagioclase ..	2,920	39·14	2·66	104·11	38·48
Biotite	396	5·30	3·00	15·90	5·87
Hornblende ..	220	2·97	3·20	9·50	3·51
Magnetite ..	76	1·02	5·17	5·27	1·94
Apatite	30	0·40	3·20	1·28	0·47
Pyroxene ..	50	0·67	3·40	2·27	0·84
	7,460	99·99		270·54	99·97

* *Analysis of specimen given in preceding table of analyses (No. 1).*

(2) ST. GEORGE AND MOONSTONE COMPANY'S SHAFT.

Minerals.	Total Diameters	Percentage Volume.	Specific Gravity.	Gravimetric Proportions.	Mineral Percentage.
Quartz	2,714	34·83	2·65	92·29	34·49
Orthoclase ..	1,472	18·89	2·55	48·16	18·00
Plagioclase ..	3,003	38·55	2·66	102·54	38·32
Biotite	424	5·44	3·00	16·32	6·10
Hornblende ..	87	1·10	3·20	3·52	1·31
Magnetite ..	38	0·49	5·17	2·53	0·94
Apatite	54	0·69	3·20	2·20	0·82
	7,792	99·99		267·56	99·88

MINERALOGICAL CHARACTER.

The minerals of the grano-diorite appear to be, in the usual order of abundance, plagioclase, quartz, orthoclase, biotite. In addition sections may contain a few individuals of hornblende or microcline. Accessory magnetite and apatite are always present. Zoisite, epidote, and sericite occur as secondary products.

Quartz.—This is, after plagioclase, the most abundant. It is crowded with fluidal cavities, and often impregnated with minute grains of magnetite or ilmenite. It encloses occasional idiomorphs of apatite.

Felspar.—A striated plagioclase predominates. Determinations by the Michel-Lévy method gave maximum extinction angles corresponding to Andesine of Ab_3 An_2 composition.

The plagioclase is mostly idiomorphic. In some cases it exhibits shadow strains. The section from the St. George and Moonstone shows this well. There is frequent sanssuritization with the development of epidote and zoisite. Zoning is most prevalent, and twinning on the Carlsbad law was frequently observed.

Orthoclase partially replaced by small blades of sericite is always present in subordinate quantities. Microcline is only rarely present.

In specimens of the dioritic facies, the plagioclase is an acid to medium labradorite giving extinction angles up to 36 deg. Orthoclase is less frequent.

Biotite.—Pale green to yellowish-brown biotite is practically the only ferro-magnesian mineral present. It is always plentiful in short blades, and is mostly altered and associated with knots of black iron ore. The flexure of the cleavage planes was noticed in several specimens. It encloses apatite.

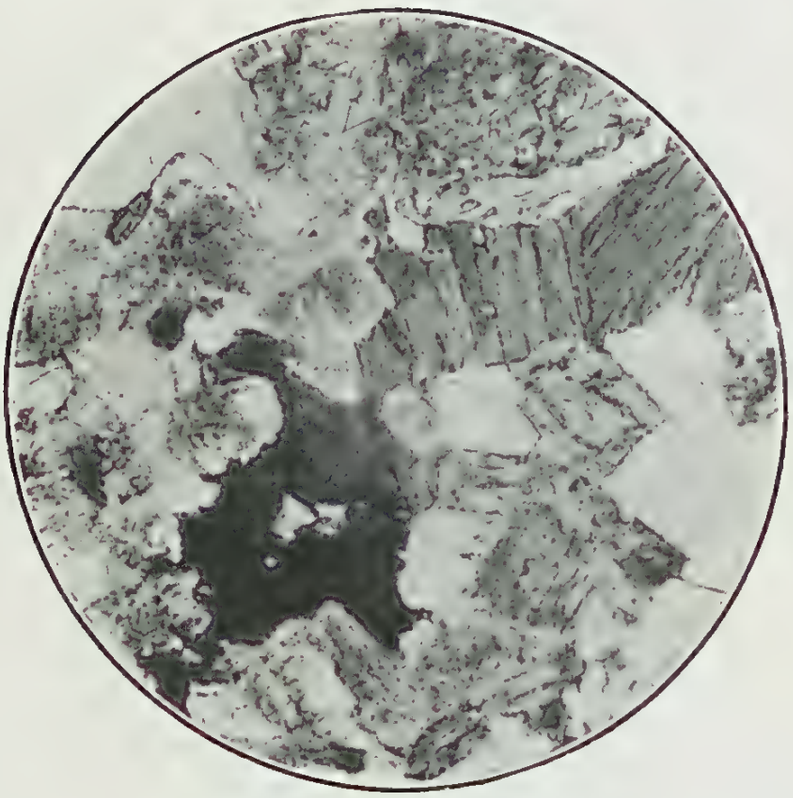
Hornblende.—The most noticeable feature of the grano-diorite is the almost complete absence of this mineral. In all of the sections, with one exception, one or two small individuals only were noticed. In the dioritic facies it has supplanted biotite as the chief ferro-magnesian mineral although the latter is also present. A pale green variety, strongly pleochroic, is most usual. It is sub-idiomorphic, and usually twinned. It encloses both biotite and apatite, and is at times intergrown with the former. Sections perpendicular to prism faces shewing the characteristic cleavage are usually seen.

Accessory Minerals.—Apatite is a constant accessory in small prisms or grains. It is most frequently enclosed in the felspars. Magnetite is abundant, and while usually segregated around the biotite may be enclosed in the quartz or felspar. It noticeably decreases in amount when hornblende has supplanted biotite.

DISTRIBUTION AND AGE.

The grano-diorite occupies the whole of the area mapped with the exception of tracts along the western and northern boundaries and in the north-east. To the south there are small areas of other rocks, but of the whole area it probably occupies almost four-fifths. It exclusively forms the country rock of the auriferous reefs. With regard to the age of the grano-diorite no definite statement can be made. It intrudes the pre-Devonian schists, and according to Dr. R. L. Jack the Lower (now regarded

Plate 15.



No. 1—Grano-diorite, New Queen Central Mine (97).
Polarised light × 30.

Quartz shows clear white, shaded crystals consist of clouded orthoclase and plagioclase, biotite runs right across centre of field.

[*Photos., J. H. Reid.*

No. 2—Grano-diorite, New Queen Central Mine (97).
Xd. nicols × 30.

as Middle—J. H. R.) Devonian series are seen resting on it to the north of the Burdekin River. He also refers to the pre-Devonian granite of the Coast range with which, according to the map accompanying the report, it is continuous. The relations of the intrusion to stratigraphical rocks of definite age can only be studied outside of the Charters Towers Goldfield. At present it can only be regarded as of Lower Devonian or pre-Devonian age.

DESCRIPTIONS OF SPECIMENS.

(*a*) *Grano-diorite* from Brilliant P.C. Mine, crosscut near main shaft, depth 1,613 feet. Specimen No. 108.

Megascopic.—Light grey in colour, medium grained rock consisting principally of colourless quartz granules up to 3 mm. in diameter and felspar. The felspars are white in colour and tabular, and individual crystals are small but form patches up to 1 c.m. across. Biotite is evenly distributed in small lustrous plates. Hornblende is not recognisable.

Microscopic.—Quartz is abundant in both small and large grains, crowded with fluidal cavities, and it occasionally envelopes biotite, while inclusions of both apatite and magnetite are present.

The felspars are moderately fresh and mostly idiomorphic. Zoning is frequent, and there are several instances of combinations albite and Carlsbad twins. Some are altered and show incipient products of sanssuritization. A striated plagioclase is most abundant, and angles of extinction for the lamellæ range from 19 deg. to 23 deg. Orthoclase is present and constitutes about one-third of the felspar content. Scales of sericitic mica are present in several of the crystals.

Microline is entirely absent.

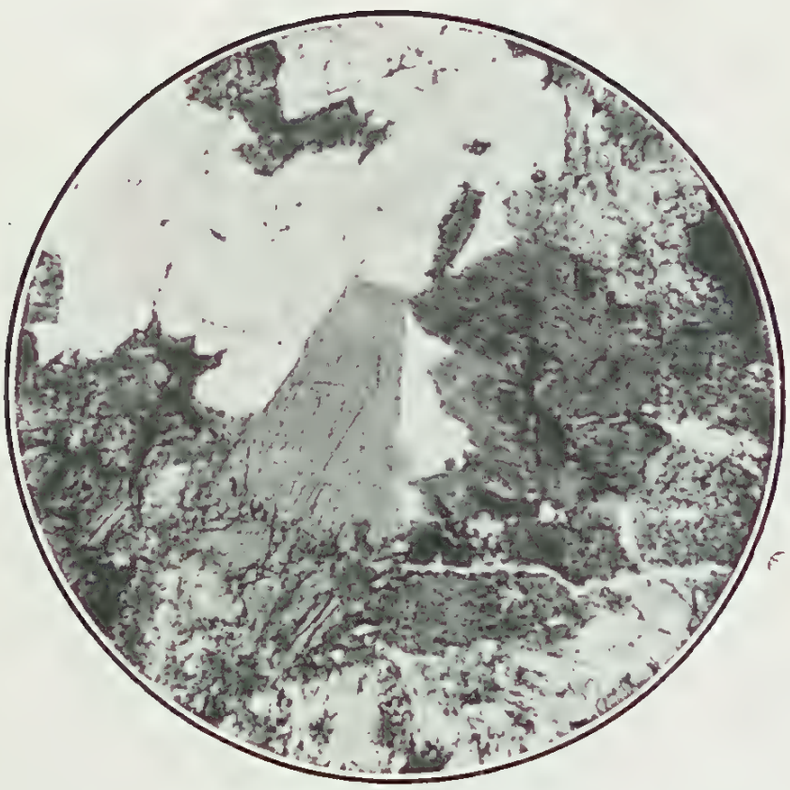
Of Hornblende one small individual (1 mm. + 0·5 mm.) was noticed. It was pale green and slightly pleochroic.

Biotite appears to form about 8 per cent. of the rock in blades averaging 1 m.m. in length. It is pale green to yellowish-brown, but is discoloured sometimes with separation of black iron ore. Magnetite is fairly abundant as an accessory. Apatite is rather scarce in this specimen. It is in small prisms enclosed mostly in the quartz.

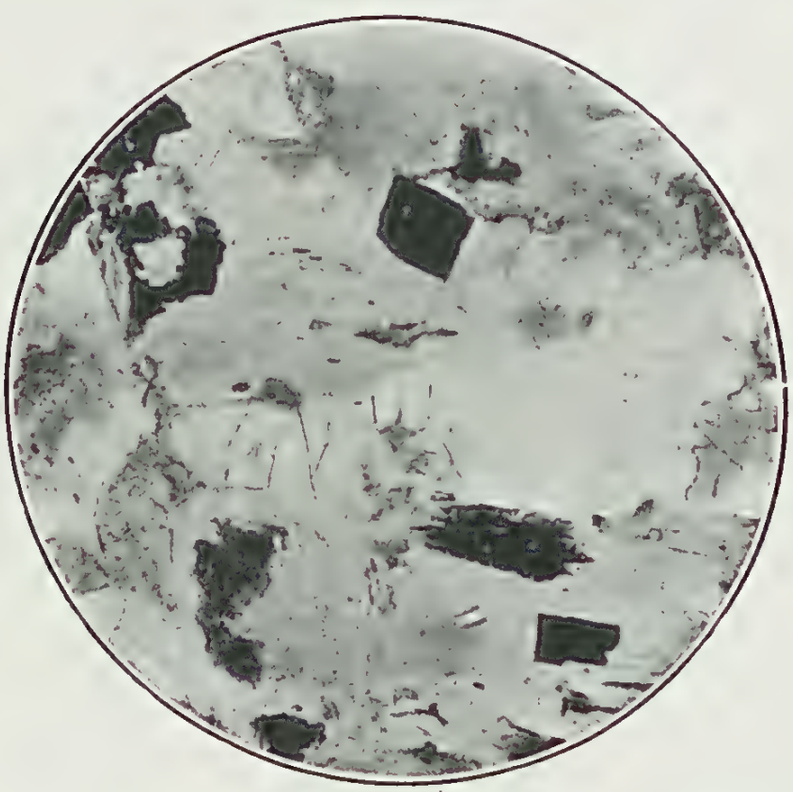
(*b*) *Quartz diorite* (differentiate) from outcrop on Townsville Road. Specimen No. 119.

Megascopic.—A dark grey medium grained rock, consisting of about equal proportions of felspar and iron-bearing minerals.

Plate 16.



No. 1—Quartz-diorite (differentiate), Townsville Road (119).
Xd. nicols × 30.
(*Note.—Hornblende, showing cleavages, projecting into quartz (clear white). Remainder of field is mostly altered plagioclase showing traces of albite twinning.*)



[*Photos., J. H. R.*
No. 2—Lode Rock, *Brilliant Lode,* Brilliant Central Mine (93).
Polarised light × 30.
(*Note formation of cubes of secondary pyrite. Quartz (clear white) alone unaltered. The shaded field is mainly calcite.*)

A little quartz can be seen. The felspar is white to pale green in colour with crystals measuring about 2 m.m. across. Hornblende is abundant, and to a less extent brown and black mica.

Microscopic.—The felspars are very much altered by weathering, and sections suitable for determining the plagioclase were rare. Unsatisfactory determinations indicated labradorite, but from other sections examined this can be safely considered as the prevailing plagioclase for this type. No orthoclase could be definitely detected, but probably some is present in the highly altered felspar.

Much of the hornblende is chloritized but many crystals shew the characteristic cleavage, and are strongly pleochroic. All the larger individuals are twinned. They occasionally shew crystal outlines, but are apparently modified by decomposition. It is intergrown with biotite and encloses both that mineral and apatite. Biotite is very altered, but recognisable by its uniformly straight extinction. The ferro-magnesian minerals approximately form between 30 to 40 per cent. of the rock, of which hornblende is more abundant. Interstitial quartz is largely present, and this individual rock specimen may be considered a quartz-diorite. Magnetite as small grains occurs more sparingly than in the normal grano-diorite. Apatite is abundant in relatively large sub-hedral crystals and grains.

Analysis of Quartz-diorite, Townsville Road (No. 119).

SiO_2	56·56	H_2O-	0·24
Al_2O_3	16·73	TiO_2	0·59
Fe_2O_3	3·54	P_2O_5	0·29
FeO	2·54	FeS_2	0·23
MgO	4·68	Cr_2O_3	trace
CaO	6·80	MnO	0·12
Na_2O	4·65		
K_2O	2·05		100·20
H_2O+	1·18		

Analyst : P. Mansini.

Norm of Quartz-diorite (No. 119).

Quartz		3·96	Magnetite		5·10
Orthoclase		11·68	Ilmenite		1·22
Albite		38·77	Apatite		0·67
Anorthite		19·18	Pyrite		0·23
Diopside	3 Fe O . Si O_2 43 Mg O . Si O_2 46 Ca O . Si O_2	10·03			98·64
Enstatite	1 Fe O . Si O_2 28 Mg O . Si O_2	7·80	Water		1·42
					100·06

(*c*) *Grano-diorite* (lode-formation) from Brilliant lode in the Brilliant Central Mine. Locally known as altered granite or "formation." Specimen No. 93.

Megascopically it appears as a dark grey, decomposed granitic rock, with the addition of abundant pyrite in grains or fragments of cubes. It is stained yellowish-green in parts, which may indicate epidote, and the felspars are kaolinized.

Under the microscope the quartz only is unaltered. The felspars are too decomposed to show outlines or twinning, and are replaced by calcite, kaolin, pyrite, and sericite. No biotite or chlorite present. There are micro-crystalline aggregates of alteration products shewing high double refraction. Calcite is particularly abundant.

QUARTZ-PORPHYRY.

This rock-type is confined to the eastern portion of the field in the form of large and small dykes, intrusive in grano-diorite. It is a dense siliceous rock and outcrops are very noticeable. Along the peripheries of the dykes are narrow zones of altered, schistose, grano-diorite with large blebs of quartz. This is probably the formation mapped in as quartz-schist on the former map. On that map however, it is often shewn in the form of narrow intrusive dykes. This rock is most abundant to the east of Gladstone Creek, but extends west nearly as far as Vesuvius Hill. About five miles south of the city there are several isolated areas of porphyry. There is no evidence to shew its field relations to the quartz-porphyry of Gladstone Creek, and mineralogically it is a distinct type.

DESCRIPTION OF SPECIMEN.

Quartz-porphyry, near Needham's Orchard, Gladstone Creek. Specimen No. 65.

This rock is light grey in colour. The groundmass is aphanitic, grey in colour, with small blebs of quartz. Small, black patches indicate the aggregates of biotite and magnetite. It is very hard and compact.

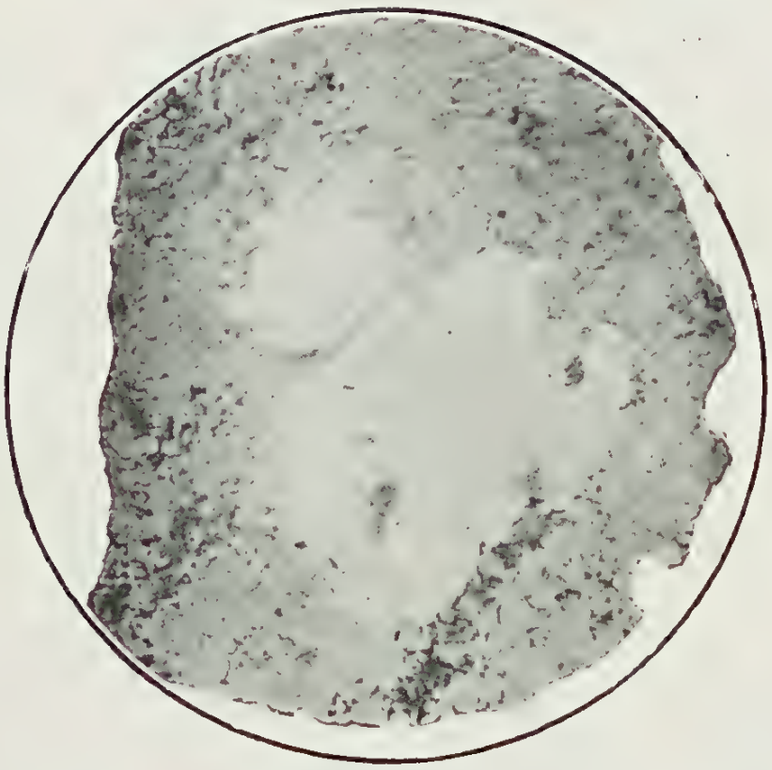
Under the microscope the groundmass of rock consists of a microcrystalline aggregate of quartz and felspar with patches of biotite and a little magnetite. Chlorite is present. The phenocrysts are rounded quartzes averaging 2 m.m. in diameter.

ANALYSIS OF QUARTZ-PORPHYRY, GLADSTONE CREEK (No. 65).

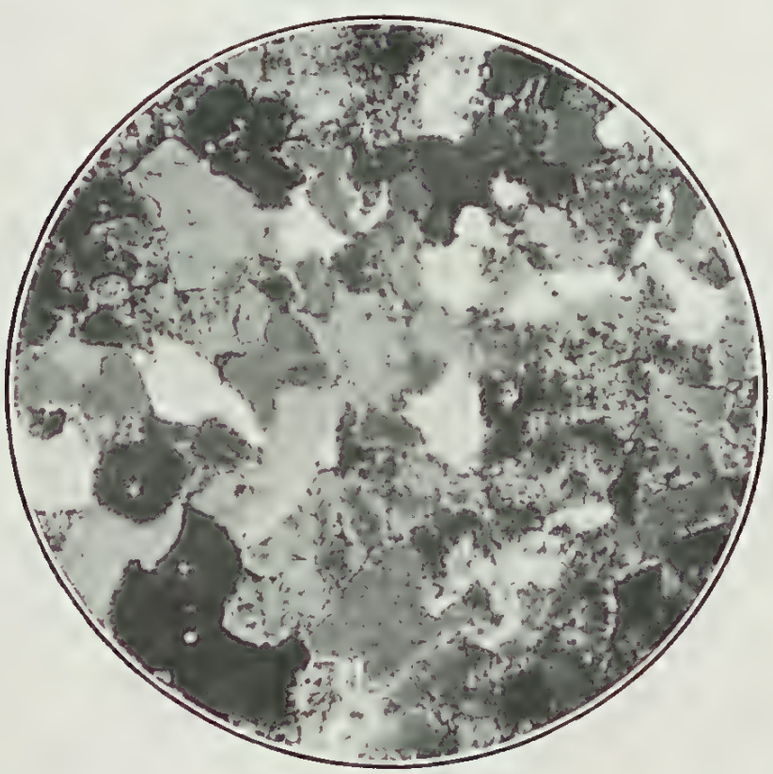
SiO_2	.. ..	67·88	$H_2O -$	0·08
Al_2O_3	.. ..	14·91	TiO_2	0·29
Fe_2O_3	.. ..	2·48	P_2O_5	0·10
FeO	.. ..	1·15	S (as FeS_2)	0·39
MgO	.. ..	0·91	Cr_2O_3	nil
CaO	.. ..	2·80	MnO	0·20
Na_2O	.. ..	5·68		
K_2O	.. ..	2·26		100·42
$H_2O +$	.. ..	1·29		

Analyst : P. Mansini.

Plate 17.



No. 1—Quartz-porphyry, near Needham's, Gladstone Creek (65).
Xd. nicols × 30.
Phenocrysts are quartz, ground mass consists of quartz and felspar with a little biotite and magnetite.



[*Photos., J. H. R.*
No. 2—Aplitic-granite, East of Gladstone Creek (75).
Xd. nicols × 30.
The field is mainly quartz and orthoclase with subordinate plagioclase.

NORM OF QUARTZ-PORPHYRY (No. 65).

Quartz	20·34	Hematite	2·08
Orthoclase	12·79	Ilmenite	0·61
Albite	47·68	Apatite	0·34
Anorthite	8·90	Pyrite	0·73
Diopside { 2 Fe O . Si O_2 / 3 Mg O . Si O_2 / 5 Ca O . Si O_2 }	3·43		99·00
Enstatite (Mg O . Si O_2)	1·40	Water	1·37
Magnetite	0·70		100·37

Quartz-Porphyry from hill south of Hogsflesh Creek. Specimen No. 83.

The colour is dark grey, imparted to it by the aphanitic groundmass which is only relieved by phenocrysts of partially altered, dull white, felspar. It assumes a light grey colour on weathering. It is very hard and compact.

In thin section the groundmass appears as a microscopic mosaic of quartz grains with altered felspar, hornblende, and needles and prisms of apatite. Larger laths of green, strongly pleochroic, hornblende are very abundant. The phenocrysts consist of altered felspar, up to 2 m.m. in diameter, hornblende and a few blades of biotite. The felspar and hornblende are corroded.

FIELD RELATIONS.

While intrusive in the grano-diorite the porphyries antedate the oldest diorite and the aplitic granite, dykes of which can be seen intersecting it west of Gladstone Creek and south of Hogsflesh Creek.

APLITIC GRANITE.

This rock is intrusive in the grano-diorite. The most extensive outcrop occurs to the east of Gladstone Creek covering an area of about 60 acres. It is however remarkable for the number of dykes that occur distributed over the whole field. These can be seen radiating through the surrounding country from the intrusion referred to above. They have no regularity of strike or dip, and range in thickness from a few inches to 25 feet. On account of their siliceous nature and fine grained texture, they weather out conspicuously from the grano-diorite. Thus dykes two and three inches thick can be traced where the country is devoid of vegetation, as, for example, around some of the creeks at Millchester. This rock has been called felsite on the former geological map. With dykes varying so much in thickness and with unequal rates of cooling some of these may appear felsitic, and every gradation in grain size may be expected. In a good number of the specimens collected the rock is fine grained, but the quartz and felspar could be separated with the unaided eye. There are a number of groups of large

dykes scattered over the field which in weathering have formed local eminences. This intrusion appears to have had no influence on the deposition of the gold ores. The characteristic colour is pink, but is often white on weathered surfaces.

MINERALOGICAL CHARACTER.

The chief constituents are quartz and orthoclase in about equal proportions. Both are allotriomorphic. In a very subordinate degree plagioclase is present in idiomorphic crystals. Extinction angles, in symmetrical sections, range from 9 deg. to 11 deg., so oligoclase-andesine is suggested. Microcline and a little muscovite are present in the dyke-rocks examined, and both muscovite and biotite are present in small amounts in the intrusive mass. Magnetite is inconspicuous.

DESCRIPTION OF SPECIMEN.

Aplitic granite from large intrusion east of Gladstone Creek.

Specimen No. 75.

The rock is phanerocrystalline, but very fine grained and pink in colour. Quartz is colourless and difficult to distinguish. Small crystals of pink orthoclase appear predominant. Black specks of biotite occur widely distributed.

Microscopic.—The quartz is clear and with cloudy orthoclase forms a granular mosaic. Together they form over 90 per cent. of the rock. The orthoclase is allotriomorphic, and in greatest dimension averages about 0·5 mm.

Plagioclase is present sparingly in idiomorphic crystals. It approximates to oligoclase-andesine in extinction. Small clusters of narrow blades of biotite occur sparingly. Muscovite is more generally distributed over the field, and is at times enclosed in the felspars. A few small grains of magnetite are present.

ANALYSIS OF APLITIC GRANITE, SUNBURST ROAD (No. 95).

SiO_2	.. ..	71·71	H_2O – .. .. 0·10
Al_2O_3	.. ..	13·36	TiO_2 .. .. 0·03
Fe_2O_3	.. ..	1·03	P_2O_5 .. .. 0·13
FeO	.. ..	0·21	S (as FeS_2) .. .. 0·14
MgO	.. ..	0·51	Cr_2O_3 .. .. absent
CaO	.. ..	0·90	MnO .. .. 0·10
Na_2O	.. ..	5·11	
K_2O	.. ..	6·73	100·57
H_2O +	.. ..	0·51	

Analyst : P. Mansini.

NORM OF APLITIC GRANITE (No. 95).

Quartz	.. .. ..	20·76	Soda metasilicate ($Na_2O . SiO_2$) 2·17
Orthoclase	.. .. ..	39·48	
Albite	.. .. ..	30·92	99·78
Amite	.. .. ..	2·77	Water 0 61
Diopside	.. .. ..	3·07	TiO_2 .. .. .. 0·03
Apatite	.. .. ..	0·34	
Pyrite	.. .. ..	0·27	100·42

FIELD RELATIONS.

This granite is intrusive in the grano-diorite, quartz-porphyry, and Warrior diorite, and therefore of later age. It is itself intruded by the diorite of Buckland's Hill and by the later diorite-porphyrite dykes. The granite-pegmatite dykes on the geological map are probably a phase of this intrusion.

DIORITE AND RELATED DYKE-ROCKS.

Apart from the grano-diorite batholith, intrusions belonging to the diorite group overwhelmingly preponderate amongst the remaining igneous rocks. They include plutonic diorite and dykes of similar composition and of different ages. They comprise the following five groups:—

"Warrior" diorite (porphyrite).
Buckland's Hill diorite and associated dykes.
Diorite-porphyrite dykes (older series).
Diorite-porphyrite dykes (younger series).
Hornblende-porphyrite dykes.

The greatest development of the diorite-porphyrite dykes is confined to the auriferous portions of the field, and they thus appear to be genetically connected with the deposition of the gold ores. This question is discussed in the chapter dealing with the genesis of the ores.

"Warrior" Diorite (porphyrite).

A few hundred yards south of the Warrior reef the most northerly outcrop of this intrusion occurs. It then extends for about 2 miles in a south-westerly direction as far as the Merrie Monarch workings. Further to the west, and north of the Black Jack Mines, is an area of diorite. It is not clear to which diorite intrusion this latter belongs. The outcrops of the former are prominent and easily traced. It is intruded by dykes of aplitic granite, and is thus of earlier age than the remainder of the diorite group, all of which intrude that formation. No reefs of a payable nature have been found associated with this diorite, and it is restricted to a part of the field several miles distant from the main groups of mines. A porphyrite dyke of similar mineral composition, trending east and west at Millchester, and faulted by aplitic granite, is tentatively placed with it, being of approximately similar age. It is possibly the most northern exposure of this intrusion.

DESCRIPTION OF SPECIMEN.

Diorite porphyrite from small intrusion south-west of Warrior Mines. Specimen No. 82.

The rock is dark coloured and porphyritic. The groundmass is aphanitic. Phenocrysts of light grey plagioclase up to 2 m.m. across are abundant, and give the rock a lighter shade.

The microcrystalline groundmass consists almost entirely of green to yellow hornblende and felspar. The hornblende is strongly segregated in patches the individuals of which are partly idiomorphic. Magnetite is present in very small amount. Phenocrysts of tabular labradorite are abundant. They are clouded, but show the albite twinning clearly. In portions of the rock they are crowded together, only being separated by narrow tracts of the groundmass.

Buckland's Hill Diorite.

This is the most extensive diorite intrusion on the field, and covers a considerable area to the north-west of the city, where it is intruded solely in the metamorphic series at the surface. A prominent outcrop is the crest of Buckland's Hill, just on the City boundary, where it has in the past been quarried for road making. Dykes connected to individual masses of the intrusion are very abundant in the schists, where they conform to the strike of the schists and apparently to the dip also. Dykes up to 20 feet in thickness extend across Gladstone Creek to the north-east of Millchester, and continue in great numbers to the eastern boundary in the grano-diorite. They have a similar strike—from north-west to south-east. Both in the schist and grano-diorite the outcrops form notable eminences, more particularly in the former where the diorite occupies the hills and the schists the valleys. The outcrops are for the most part situated at considerable distances from the auriferous reefs, but the dioritic dykes which are apparently a later phase of the main intrusion, on account of their proximity and similar chemical composition, are intimately associated with the reefs.

APPEARANCE.

On fresh fractures the rock is almost black in colour and weathers to dark grey. It is fine grained, but black hornblende and dull grey felspar, which constitute practically its only constituents, can be recognised easily. In dykes it is finer grained and is often aphanitic.

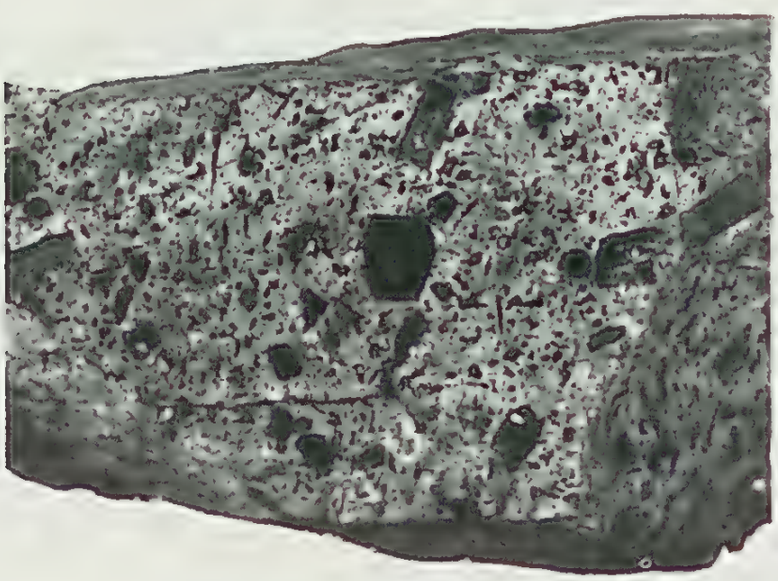
MINERALOGICAL CHARACTER.

The essential minerals are labradorite and hornblende, the former being the chief constituent. Apatite and magnetite are

Plate 18.

[*Photo., J. H. R.*

No. 1—Diorite, Buckland's Hill (16).
Polarised light × 30.
Showing plagioclase and hornblende intergrown.



[*Photo., A. B. W.*

No. 2—Diorite-porphyrite.
Dyke Rock (natural size) showing Crystals of Hornblende, east of Racecourse.

constant accessory minerals, and occasionally plates of ilmenite are present. Ilmenite was not noticed in the dyke rocks.

DESCRIPTION OF SPECIMEN.

Diorite from Buckland's Hill. Specimen No. 16.

The rock is holocrystalline and fine grained but non-porphyritic. The most abundant mineral is plagioclase, which is wholly idiomorphic and moderately fresh. Angles of extinction and relief indicate a basic labradorite. It is present as elongated tabular crystals in length up to 3 m.m. Zoning, so prevalent in the plagioclases of the grano-diorite, is conspicuously absent. Yellow to green hornblende is the only other mineral in any abundance. It is partially idiomorphic, but much of it encloses the felspar plates and fills the interstices, indicating a partial precedence for the felspar in order of crystallization. Ilmenite, considerably altered, is present in grains up to 1 m.m. in diameter, and has a tendency to be segregated. Apatite is abundant in small needles, and magnetite is sparingly present.

ANALYSIS OF BUCKLAND'S HILL DIORITE (No. 123).

SiO_2	48·08	H_2O-	0·06
Al_2O_3	14·84	TiO_2	0·75
Fe_2O_3	1·55	P_2O_5	0·22
FeO	7·27	FeS_2	0·56
MgO	6·02	Cr_2O_3	absent
CaO	14·20	MnO	0·32
Na_2O	4·57		
K_2O	1·70		100·74
H_2O+	0·60		

Analyst: P. Mansini.

NORM OF DIORITE (No. 123).

Orthoclase	10·01	Apatite	0·34
Albite	3·14	Pyrite	0.56
Anorthite	15·01		
Nepheline	19·03		99.68
Diopside	44·89	Water	0·66
Olivine	3·24		
Magnetite	2·09		100·34
Ilmenite	1·37		

DIORITE PORPHYRITE DYKES.

Running through the main auriferous area of the field are two series of igneous dykes ranging from a few inches to twenty feet in thickness. Twenty feet is an exceptional thickness, and most of the dykes range from one to three feet. They can be divided into two series by their uniformity of strike alone, but, in a number of instances, dykes of one series cut cleanly through the other, sometimes with no displacement of the older dyke. The older series runs from north-east to south-west, the average strike being between 220 deg. and 230 deg. east of north. The younger series runs from north-north-west to south-south-east, and the average strike is about 330 deg. east of north. Evidence

of their relative age is to be seen in the Girls' School Reserve and in the tramway cutting near the Day Dawn Block and Wyndham main underlie shaft. It is only where the grano-diorite outcrops that these dykes can be easily traced, and in the country surrounding Towers Hill and on the Day Dawn Ridge they may be seen in great numbers. On the rocky out-crops of the hills they can be traced by the eye for sometimes half-a-mile by narrow ribands of fresher and taller grass marking their outcrops. In the railway cutting near the Hawkes-bury Hotel a large number are exposed. In the City they can not be traced at the surface, but the mine workings show that they are continuous underground. They were found to extend underground as far easterly as the western boundary of the

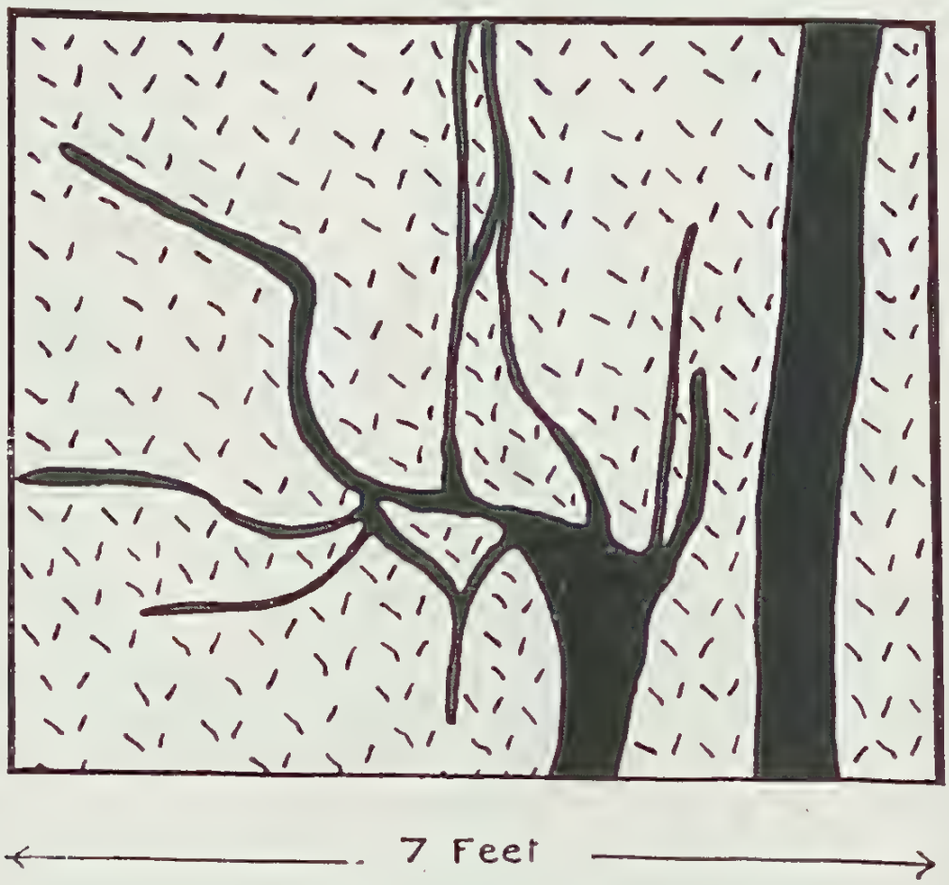


Fig. 5.—Diorite-porphyrite Dykes in Grano-diorite, Mills's United Mine.

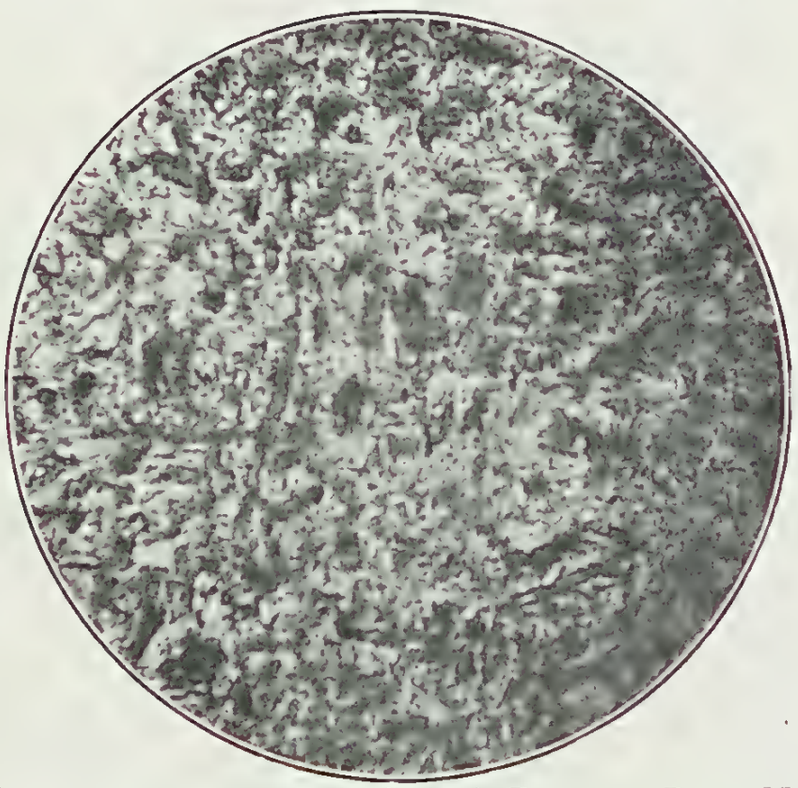
(*Crosscut No. 14 Hanging-wall level. To Scale—Section 7 feet across.*)

Brilliant Extended Mine and the most easterly workings of the Brilliant Deeps. They have also been reported as occurring in the Brilliant and St. George Mine, now closed down. In the mines further east examined—viz., the Brilliant, Central, Bonnie Dundee, and Queen Tribute—no dykes were seen, and in the absence of any evidence of heavy faulting it is possible that they have died out in the intervening country. The dykes have a strong tendency to run in groups, and it is rather the

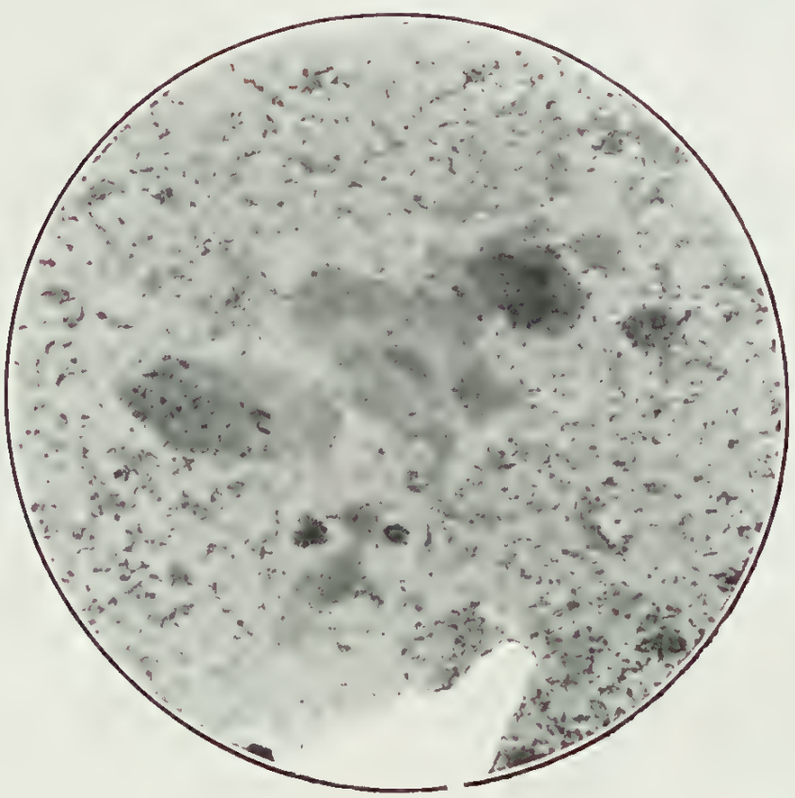
exception to find an isolated dyke. The small dykes of groups undoubtedly coalesce to form the big dykes, or these split up to form the groups. Most of the dykes are vertical or nearly so, while a few were noticed to have dips as low as 70 deg. A big isolated group of the older dykes occurs about one and a-half miles to the south of the City, and can be traced on the surface from the Ruby group of mines to the Mary Lou. It is noteworthy that on the line of strike of this group rich returns of gold have been obtained from the Identity, Good Hope, Ruby, and Mary Lou Mines. Over the whole of the southern part of the field isolated dykes occur, most of which conform in strike to one or other of the series, but, owing to the thickness of soil, are difficult to trace. Bands of dark-red soil, which are conspicuous against the light-coloured soil of the grano-diorite are sufficient indication of the existence of dykes, and sooner or later invariably lead to an outcrop. To the east and north of Millchester there is a complex system of dykes mapped in by A. Gibbs Maitland, and shown on the former geological map of Charters Towers. This area, owing to its complexity, was not resurveyed on the basis of the new topographical map, but a reconnaisance of the area showed that dioritic dykes of two ages are present there. One group is undoubtedly connected with the Buckland's Hill intrusion, as they are continuous with big dykes to the east of Gladstone Creek which are identical in strike and composition with the dykes associated with that intrusion. These dykes are, in several instances to the east of Gladstone Creek, intersected by later dykes trending north-east to south-west, and in the north-eastern portion of the area mapped, dykes of this trend are occasionally picked up. It is probable from their approximation to the strike and composition of the earlier series of dykes in the auriferous belt that they are of similar age. In this case the dykes of the auriferous belt are of later age than the Buckland's Hill intrusions.

There is also abundant evidence in mine workings to show that the Day Dawn fissure has, for the greater part of its known course, opened along a dioritic dyke running almost due east and west. This represents an abnormal trend to both known series of dykes. Owing to its decomposition and the timbering of all workings underground where it occurs, it was impossible to ascertain its relations to the other dykes from an intersection, or to obtain sufficiently fresh material for chemical analysis or micro-sections.

Plate 19.



No. 1—Diorite-porphyrite (Older Series), Brilliant Deeps Mine (101).
Xd. nicols × 30.
The groundmass consists mainly of laths of hornblende with labradorite.



[*Photos., J. H. R.*

No. 2—Diorite-porphyrite (Younger Series), Mills' United Mine (125).
Polarised light × 30.
Phenocrysts of hornblende in centre, groundmass is hornblende and labradorite.

In hand specimens the dyke rocks are dense, hard, and aphanitic. They are often porphyritic, the phenocrysts being hornblende. The colour is dark grey to black, and they are not unlike some basalts in appearance. In micro-sections the fabric is pilotaxitic for narrow dykes. In the big dykes the plagioclase is partially allotriomorphic, thus determining the prior crystallization of the hornblende.

MINERALOGICAL CHARACTER.

Although of different age there is little variation in the mineral composition of the two series. They both consist almost wholly of hornblende and labradorite in apparently equal proportion. Orthoclase, magnetite, pyrite and apatite are the only accessory minerals, the latter being very abundant in fine needels.

Plagioclase.—In sections cut from the big dykes, fair-sized crystals are found showing repeated twinning. In the narrow dykes they occur as narrow laths, and sometimes show simultaneous crystallization with the hornblende.

Determinations by the Michel-Lévy method indicate a composition approximating to Ab_7 An_{13}.

Hornblende.—Two generations of hornblende are sometimes seen. When the rock is porphyritic, which occurs occasionally in both series, the phenocrysts always consist of this mineral. They range up to 2 mm. × 1·5 mm. in size, while in the groundmass they average about 0·2 mm. in breadth. In the big dykes well-formed crystals showing both cleavages are abundant up to 1·5 mm. in diameter, while in the narrow dykes thin prisms are practically the only form present.

Pyrite.—This is associated with magnetite, the latter commonly forming rims around it. It is present in all sections.

Older Series.

Diorite-porphyrite from New Brilliant Freeholds Mine, Specimen No. 128.

The rock is porphyritic to a slight extent, as several corroded phenocrysts of hornblende are present; the largest measuring 1 mm. × 0·5 mm. The groundmass consists chiefly of hornblende, and the fabric is hypidiomorphic-granular. The hornblende is mostly in elongated, very narrow, prisms, and is usually fresh. It contains much magnetite, both primary and as an alteration product. The interstices between the ferromagnesian minerals are filled with tabular plagioclase, seldom showing twinning, and subordinate orthoclase. Apatite is fairly

abundant in the felspar. Magnetite showing cubical development is associated with the hornblende where the latter is quite fresh, and also in small grains where decomposition has occurred. Pyrite is rather scarce, and is much less abundant than in any other sections of these dyke rocks examined.

Younger Series.

Diorite-porphyrite from Mills's United Mine; end of No. 14 crosscut; depth, 2,322 ft; dyke, 2 ft. thick. Specimen No. 110.

The rock is porphyritic, the phenocrysts consisting of longitudinal sections of hornblende partially altered to chlorite, the biggest being 1·5 mm. × 0·75 mm. The groundmass fabric is pilotaxitic, and consists of laths of plagioclase and thin prisms of hornblende. The felspars are slightly clouded, but most of the hornblende is quite fresh. Apatite is very abundant as needles enclosed in the felspar. Pyrite is present surrounded by rims of magnetite.

Analyses of Diorite-porphyrite Dyke Rocks.

	I.	II.		I.	II.
SiO_2	40·56	49·82	H_2O- ..	0·12	0·46
Al_2O_3	21·61	19·38	TiO_2	1·90	0·78
Fe_2O_3	5·09	3·09	P_2O_5	0·59	0·33
FeO	4·72	3·55	FeS_2	0·45	1·16
MgO	9·05	4·85	Cr_2O_3	trace	trace
CaO	8·10	9·82	MnO	0·11	0·20
Na_2O	4·60	5·56			
K_2O	2·01	0·69		100·42	100·15
H_2O+ ..	1·51	0·46			

Analyst: P. Mansini.

I. (Older Series) New Brilliant Freehold Mine (No. 128).
II. (Younger Series) Mills's United Mine, north end of No. 14 crosscut (No. 110).

Norms of the above Dyke Rocks.

	I.	II.		I.	II.
Orthoclase ..	11·68	3·89	Apatite ..	1·34	0·68
Albite	4·19	31·44	Pyrite	0·45	1·16
Anorthite ..	32·53	25·85			
Nepheline ..	18·74	8·24		98·72	99·16
Diopside ..	3·27	16·86	MnO	0·11	..
Olivine	15·45	5·08	Water	1·63	0·92
Magnetite ..	7·42	4·43			
Ilmenite ..	3·65	1·53		100·46	100·08

Hornblende-Porphyrite.

This type is distinguished in the field from the diorite-porphyrite dykes by its reddish-brown colour and needle-shaped crystals of unaltered hornblende, standing out conspicuously from the groundmass of the rock. Several dykes, up to 15 ft. in thickness, occur at Millchester around the old workings of the Identity reef and further north on the banks of Gladstone Creek. These dykes trend east and west, and can be traced on the surface for a distance of over a mile. They cut through dykes of aplitic granitic, and therefore constitute one of the

later periods of igneous activity on the field. Dr. R. L. Jack, in his report on the Identity reef, mentions a dyke of porphyry cutting the reef. If this is so, these dykes are the most recent on the field, as all the reefs seen in various parts of the field fault all the other igneous dykes.

Although payable ore has been worked in proximity to these dykes in the Identity Mine, they are totally absent from the other auriferous portions of the field, and apparently they had no influence on the formation of the ores at the Identity. Similarities in mineral and chemical composition point to a common magmatic origin for these and the diorite-porphyrite dykes.

DESCRIPTION.

Hornblende-porphyrite from Millchester. Specimen No. 76.

The rock is coloured reddish-brown, weathering to light-brown. The groundmass is aphanitic, phenocrysts of fresh hornblende are conspicuous in needle-like and narrow tabular crystals up to 7 mm. in length. Rectangular colourless felspar can also be detected as minute scattered crystals. The colour is very distinct from all other igneous rocks of the field.

Under the microscope the groundmass is seen to be coloured reddish-brown by iron stain. The minerals of the groundmass consist of plagioclase laths and tables, and hornblende. Magnetite is abundant in small rounded grains and larger subhedral crystals. Calcite has formed near the margins of large plagioclase crystals.

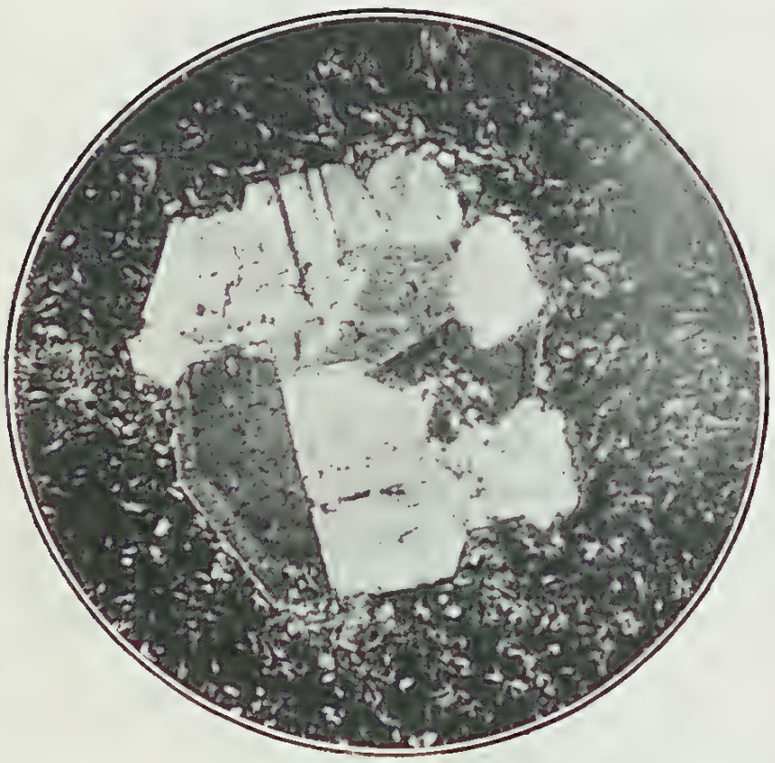
The phenocrysts consist of a medium to basic labradorite and hornblende. The former is present in pseudo-hexagonal and almost square sections, and is generally twinned on the Carlsbad law. They are often beautifully zoned (see plate 20 No. 1). Crystals up to 3 mm. in the greater dimension were measured. The hornblende appears as sections of the narrow crystals seen in hand specimens, cut obliquely to the main crystallographic axis, and do not indicate their relative size.

Analysis of Hornblende-phorphyrite (No. 76).

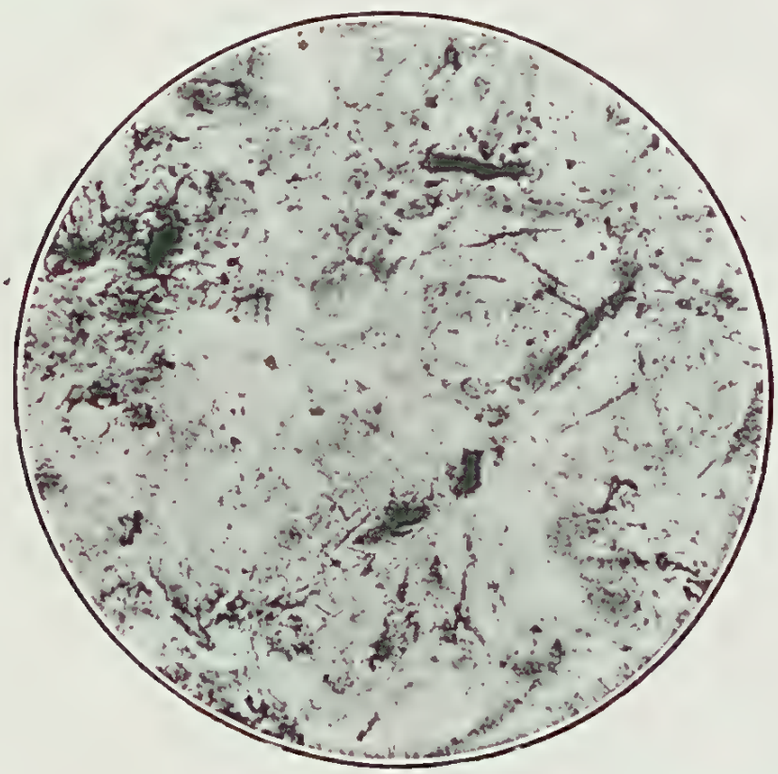
SiO_2	57·28	H_2O-	0·76
Al_2O_3	17·58	TiO_2	0·57
Fe_2O_3	4·73	P_2O_5	0·33
FeO	0·94	FeS_2	0 22
MgO	1·26	Cr_2O_3	absent
CaO	5·81	MnO	0·37
Na_2O	5·45		
K_2O	2·57		100·55
H_2O+	2·68		

Analyst: P. Mansini.

Plate 20.



No. 1—Hornblende-porphyrite, Millchester (76).
Xd. nicols × 30.
Phenocrysts of zoned plagioclase showing albite and Carlsbad twinning, groundmass is ironstained and consists of hornblende and plagioclase with iron oxides.



[*Photos., J. H. R.*
No. 2—Serpentinized Gabbro (?), North-west of Charters Towers (44).
Polarised light × 30.
Opaque mineral is hematite, tremolite is abundant. Among the secondary minerals there are traces of plagioclase, hornblende, and angite (?).

NORM OF HORNBLENDE-PORPHYRITE (No. 76).

Quartz	4·14	Ilmenite	0·91
Orthoclase	15·57	Apatite	0·67
Albite	46·11	Pyrite	0·22
Anorthite	15·85		
Diopside	6·70		97·23
Wollastonite	1·63	Water	3·44
Magnetite	2·55		
Hematite	2·88		100·67

GABBRO (?).

Rocks approximating to a gabbro in composition and texture are present as small lenticular intrusions in schist to the north-west of the City, and a few dykes corresponding to this type were found scattered over the field, intrusive in the grano-diorite. Although scattered, their distinctive appearance from all other igneous rocks of the field renders it likely that they are of similar origin. This type is represented as serpentine on the old geological map of the field. In only one instance was the formation found associated with gold ores—viz., at the Mary Lou workings, 3 miles south-west of Charters Towers. It was impossible to obtain thin sections, giving satisfactory results, of the larger intrusions, owing to the advanced stage of weathering. One section cut showed remnants of hornblende and doubtful augite, and an abundance of iron ore, as hematite, and tremolite. In hand specimens this type resembles a decomposed gabbro in colour, texture, and serpentinization. The dykes are always marked by a great deal of calcite.

A section cut from a dyke showed the rock to be allotriomorphic. A basic labradorite was the main constituent, and hornblende and diallage were both present in subordinate amounts, while the accessory minerals comprised iron ores and apatite. The rock, therefore, appears to have affinities to both gabbro and diorite. The only evidence of age furnished was a small diorite dyke intruding the gabbro. It lies between the grano-diorite and the Buckland's Hill diorite in point of age.

Chapter VI.

THE ORE DEPOSITS.

DISTRIBUTION.

The Charters Towers Goldfield has an area of 615 square miles, and in this the city occupies an almost central position. Gold has been found distributed over fully three-fourths of the field, but the deposits that made Charters Towers the premier goldfield of Australia for many years, are confined to a small area within the city and its immediate environs. Two main auriferous belts can be recognised, and in both instances they run from north-east to south-west. The more northerly, containing the Day Dawn and Brilliant lodes, may be said to start on the south-west side of the city, near the most westerly workings on the Wellington and Welcome reefs, and continues through the city extending as far as the Golden Gate and Sunburst mines on the north-east, a total distance of about 3 miles. This belt is about three-fourths of a mile wide, and it includes all the most famous mines of the field and has produced an overwhelming bulk of the total gold from the field.

The second auriferous belt, and altogether unimportant compared with the preceding, extends from the Identity Mines, Millchester, past the Ruby group and several small reefs, and terminates at the Mary Lou workings in the south-west. This is also about 3 miles in length, but is not more than 200 yards wide at its greatest width. Outside of these two belts a small number of profitable mines have been worked, but most of them are now closed. The latter include the Washington, Alexandra, Imperial, and Black Jack mines. Those working recently (year 1916) were the Cumberland and Stockholm mines. All are situated within 5 miles of the city, ranging in direction from south-east to south-west. Only one reef (the Great Britain) has been worked in the schist country lying to the north and west of the city, and that with but poor results. Numerous other workings exist further afield, but the great majority are merely surface "scratchings." Payable gold deposits have, however, been worked at The Broughton and at Rishton, 11 and 19 miles, respectively, east of Charters Towers. They are practically abandoned now. The "Outside" mines of the field have been reported on by Marks.†

† E. O. Marks. "Outside Mines of the Charters Towers Goldfield." Q.G.S. Pub. No. 238; Bris., 1913. Also "Government Mining Journal." April, 1912, p. 148.

Alluvial gold has been found at Millchester, 2 miles south-east of the city, at the Little Red Bluff and near the Warrior. Only at the firstnamed locality were the results at all payable. These alluvials consisted of cement and granitic débris near to, or underlying, Tertiary (?) sandstones. Meagre returns only have been obtained from prospecting the present stream channels in the vicinity of the auriferous reefs. After heavy storms prospectors get colours of gold even now in the gullies surrounding Charters Towers hills, but all efforts at washing and dredging the creek sands in the past have usually proved unpayable. These efforts have not been extensively pursued. Rich reef gold was found at the surface in the first days of the field, and the erosion of these must have contributed to recent alluvials. Probably prospecting has not been persevered with in getting to bedrock in the streams. The watercourses are subject to violent scouring as the result of storms of tropical intensity during the summer months, and this would be favourable to the concentration, by gravity, of the gold on or near bedrock level.

The gold deposits are confined entirely to the grano-diorite country. No payable reefs have been located in either the altered sedimentary series (schists and quartzites) or the diorite intrusions.

Of the two main belts the largest lodes existed in the more northerly one. Besides the Day Dawn and Brilliant, a number of rich reefs associated with the latter have been worked out, such as the Queen Cross reef and the Victoria and Queen reef. The Queen reef, running from near the railway station out to the Golden Gate Mine, at first a large contributor, was payable only to a depth of about 400 ft. The other important producing reefs of this belt include the Wellington, North Australian, Clark's Moonstone, Rainbow and Wyndham, Lady Maria, Mexican, St. George, St. Patrick, and Victory.

The remaining auriferous belt, including the Identity, Ruby, and Mary Lou, runs sympathetically with the main belt but about one mile to the south.

The Identity and Ruby, though small compared with the mines of the Brilliant and Day Dawn, have been very profitable.

Almost all of the grano-diorite area which surrounds Charters Towers has thus been proved more or less auriferous but, with the exception of about half a dozen isolated mines which proved payable, the only extensive deposits known have been found concentrated in the two belts, and almost wholly in the main belt, within and near to the city.

THE LODES.

Character.

With the exception of several unimportant alluvial deposits long since worked out, the Charters Towers ore-bodies are causally connected with faulting. They are to be classified as simple and composite fissure lodes occupying wholly or partly the fissures formed by two series of faults of different age and opposite strike. This implies that the deposits are approximately tabular in form, and, while this is so in general, it has to be slightly modified occasionally owing to what are locally known as "bulges," where lenticular bodies of quartz and crushed grano-diorite have formed up to nearly 50 ft. in thickness. This figure is, however, altogether exceptional, but such a bulge occurs in Mills United Mine in No. 6 east level, where a width of 50 ft. on the level was stoped out and most of which was payable ore. The stope length of this bulge was about 100 ft., gradually tapering from the centre until on the east side it formed two branch reefs and on the west it assumed the normal thickness of the reef. In section it narrowed to 10 ft. at No. 5 level and 20 ft. at No. 7.

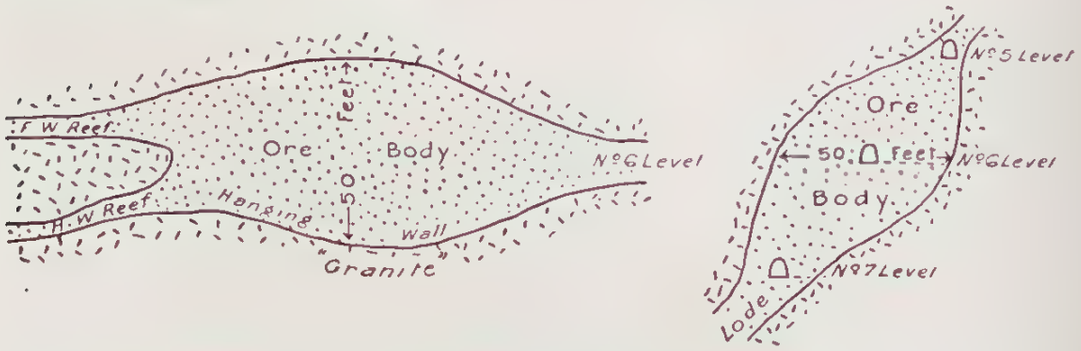


Fig. 6.—Sketch Plan and Section of "Bulge" in Day Dawn Lode, Mills United Mine.

That this may be considered in its proper perspective, it may be stated that a reef of over 6- or 7 ft. in thickness would be regarded as unusual on the field, and although there are many instances recorded of reefs attaining from 10 to 15 ft. thick, they are generally bulges of short extension. It being almost impossible to give an average thickness of reefs, it will be some criterion to state that from the local view point a reef under 1 ft. thick, for this field, would be considered small; 1- to 2 ft., fair size; 3- to 5 ft., large; over 5 ft., exceptionally large. It is a safe generalisation to say that the majority of the reefs vary from several inches to 5- or 6 ft. in thickness, but occasionally "bulge" to much greater dimensions. These bulges sustain the other evidence of inconsiderable movement along the fault

fissures, for with much movement there would be the tendency to reduce the local curvature of the walls by the abrasion of the walls which must come in contact at opposing convexities.

The origin and character of these fault fissures has been fully discussed in the previous chapter under faulting, and it is shown there, from the evidence of dislocated dykes, that the

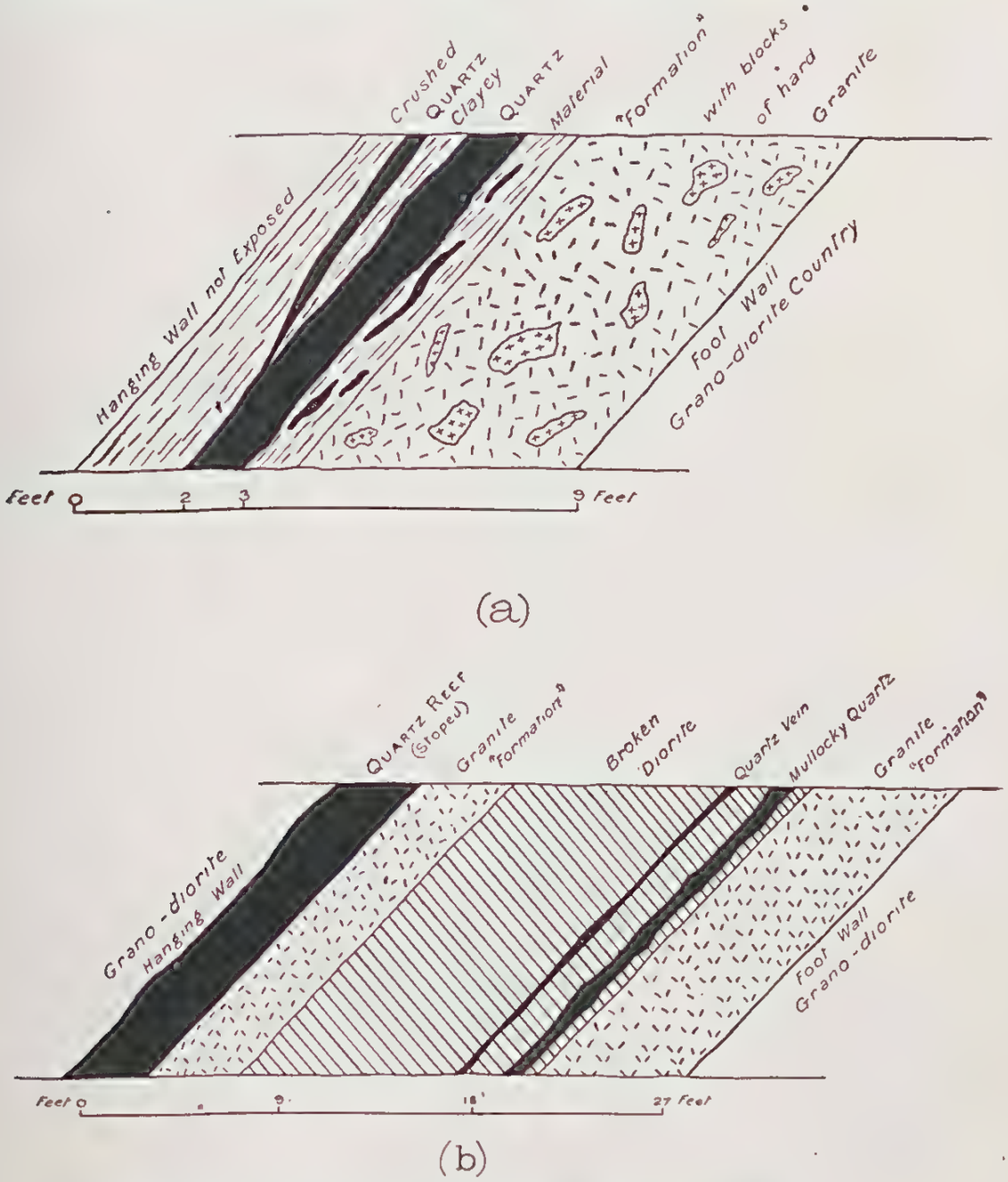


Fig. 7.—Cross-Sections of Day Dawn Lode.

(*a*) *No. 3a Day Dawn Underlie Shaft at Surface (Main Lode).*
(*b*) *Mills United Mine, No. 7 Level (Hanging-Wall Lode).*

movement was often only from 1- to 3 ft., while in no instance observed on the field could the maximum movement have been greater than about 50 ft.

The lode walls are well defined and show evidence of crushing within the lodes, being often slickensided. Occasionally the reefs are "frozen" to the grano-diorite. On the Day Dawn and Brilliant lodes 15- to 20 ft. was not an uncommon width from wall to wall. The lode material consists of quartz reefs or veins and what is locally termed "formation"—*i.e.*, crushed and altered grano-diorite. A sheared dioritic rock is also present in the Day Dawn lode. In the lodes there may be one or several reefs separated by bands of "formation." In the latter case the reefs usually junction and may then split again to follow either wall or an irregular course. The bigger lodes of the field are characterised by numerous branching veins which occasionally form loop reefs by coming back to the parent lode. This fact, when considered with the numerous fault fractures seen between the main walls of the lodes, makes it clear that lodes such as the Day Dawn and the Brilliant are not formed merely by one continuous dislocation of the country, but that along zones of weakness, now marked by the main lode channels, there were numerous fault fissures intertwining one with the other and occasionally projecting away from the main line of movement to form branch reefs with junctions varying between the horizontal and the vertical. This statement is founded on the evidence of faulting seen in many of the mines, but the best example occurs in the New Brilliant Freeholds and shows repeated dislocation of two diorite porphyrite dykes between the hanging and foot walls of the lode. (*See* Fig. 8)

In almost all the mines on the Brilliant and Day Dawn lodes, loop-reefs and branch reefs are common. The latter usually dip in the direction of the main lode and strike nearly

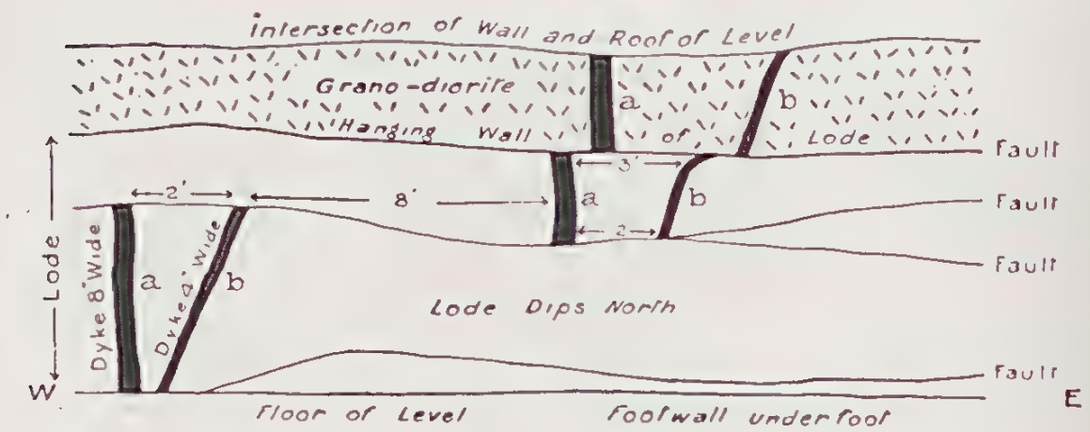


FIG. 8.—SKETCH SECTION ALONG WALL OF NO. 3 LEVEL, NEW BRILLIANT FREEHOLDS MINE.

Repeated Faulting of two Porphyrite Dykes within the Day Dawn Lode.

parallel. Their origin appears to be explained by the number of faults which occur along the lode channels, some of which diverge

at intervals and evidently afforded channels for the deposition of the ores from auriferous solutions. Replacement, as well as the filling of open fissures, has occurred along these.

With the exception of the Day Dawn, none of the lode fissures on the field appear to have been influenced in their formation by igneous rocks. Along the Day Dawn a dioritic dyke can be traced underground from the Brilliant P.C. to Mills United Mine without a break. In many parts of the latter mine, the reefs are seen to be associated with a dioritic dyke, and this is also the case in the most westerly workings of Pfeiffer's Mine. This dyke—if it be only one—can thus be traced intermittently for a distance of about 2,000 yards along the Day Dawn lode. In the Brilliant Freeholds, between No. 1 and No. 4 levels, it is at least 20 ft. wide in parts. The dyke, which has an abnormal trend in relation to all known dioritic dykes in this part of the field, has formed the line of weakness along which the Day Dawn fissures have partly opened. The Day Dawn and its branch—the Mexican reef—have the steepest dips on the field, averaging about 50 deg., while most of the others do not exceed 35 deg. It is presumed to be to the presence of this dyke that the Day Dawn owes its steeper dip and the reputation, locally, for being in diorite country. Five sub-parallel reefs have been worked on the Day Dawn, and, while none of these follow the dyke continuously, most of them have opened out on it at one or more points. That the dyke is older than the reef is evident from its broken condition, its slickensided walls, and the partial replacement of it by the reefs. If the dyke was younger and had forced its passage along the lode, the reefs and "formation" would be more or less assimilated and the lode walls probably obliterated by the viscous diorite forming a fresh contact with the grano-diorite.

Strike and Dip of Lodes.

The lodes can be divided into two groups determined by direction of strike. The first group, which occupies the older fissures, approximately follow a line trending from 10 deg. west of north to 10 deg. east of south. Amongst the more important reefs of this group there is scarcely one that would show a greater angle of variation than 10 deg. with this line. A number of the smaller reefs show less adherence to the general strike. All of these dip easterly with two exceptions—the Mountain Maid and New Dawn. The angles of dip are moderately low, and most of them would vary between that of the "Old" Queen Cross reef —viz., 27 deg., and the Victory 36 deg. Scarcely any of the reefs have a regular dip, and these figures are averages of the dips found in different mines. The average dip is about 33 deg. for

this group, which, besides the abovenamed, includes amongst others, the Just-in-Time, St. Patrick, St. George, Rainbow, North Australian, and Lady Maria.

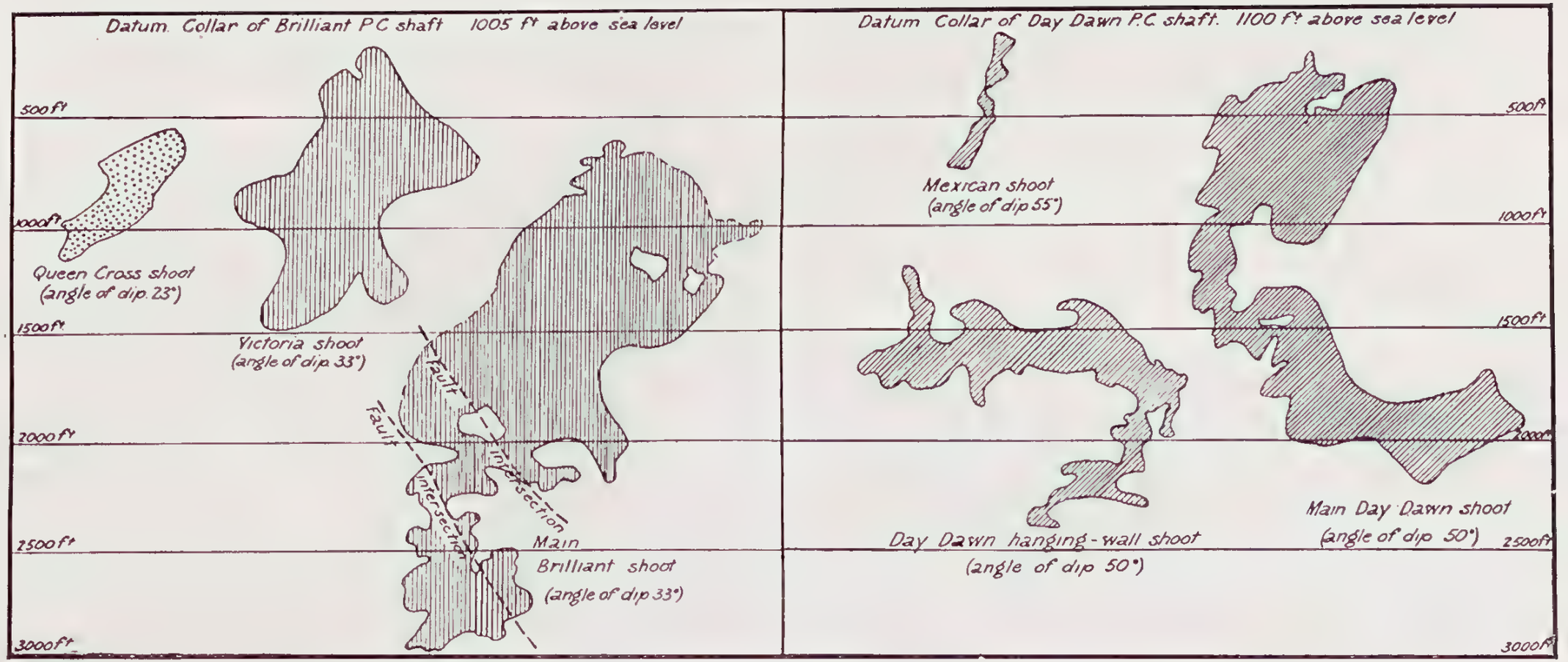
The second group of lodes follows generally a line at right angles to the preceding, and all dip northerly with the exception of the south-east Moonstone. The angles of dip range from 65 deg. in parts of the Day Dawn and Mexican to as low as 23 deg. in the south-east Moonstone. The average dip of the Day Dawn and Mexican is nearer 50 deg. There is then a considerable drop, as most of the fissures range from 30 deg. to 40 deg. The Brilliant averages about 33 deg. Other lodes of this group are the Queen, Wellington, Identity, and Ruby. Numerically, this group is not so well represented by distinct fissures, but the Brilliant and the Day Dawn lodes and associated reefs have contributed by far the greater bulk of the gold produced.

Persistence of the Lode Fissures.

In a field like Charters Towers, where the outcrops of the lodes are not striking elements of the local geology, and where information regarding the continuation of the lodes has been almost wholly dependent on the work done underground, any discussion as to the persistence of the fissures cannot be as exact as desired. Moreover, the lodes may split and follow a number of fissures, and prospecting work is carried on in these only so far as there appears a reasonable hope of obtaining a payable return in ore. As an instance, the Brilliant, as a well-defined lode fissure, can scarcely be considered to extend further west than the shaft of the New Brilliant Freeholds; but to the west thereof at least three veins have been worked, or exposed in crosscuts, whose attitude and position correspond to that of the Brilliant further east, and which, if followed, would almost certainly be found to connect to the main lode. Any of these might conceivably lead on to bigger bodies to the west, for the lodes on the field are so patchy that merely a fracture in the country with a few inches of unpayable "formation" often intervenes between points where they open out and carry payable quartz. Of all the lodes there are only two proved over one mile in length. These are the Day Dawn and the Queen. Along the Day Dawn, five reefs have been worked at different parts, and the workings on these, which are all connected, show a length of 2,200 yards, extending from the Brilliant P.C. lease to Wallis' Day Dawn. It is considered locally that workings further west may be on a continuation of the lode, but that opinion is merely speculative. The Queen and its branch, the Sunburst, have been traced about 1,800 yards.

The Brilliant, so capricious near the surface, has, between a depth of 1,000 ft. and 2,000 ft., been proved laterally for 1,300 yards. The fissure is apparently of greater extent near the surface, but owing to its pronounced poverty there has not been followed. Very few of the remaining lode fissures have been proved over 800 yards, and many of importance, which have yielded considerable gold, such as the Victory, St. George, St. Patrick, and the Lady Maria, are known for only a few hundred yards. In these cases the lengths have been determined by the distance the pay shoots could be followed, for the Victory, for example, has been worked down to a depth exceeding 1,100 ft., and if the length of outcrop is at all commensurate with the lateral extent at that depth, it must be accorded a far greater length unproved near the surface.

As regards the persistence of the lodes in depth it is desirable to consider them so far as they contain reefs payable or indicating probability of profit, for theoretically the large fissures almost certainly exceed depths beyond the limit of investigation. The depths of fissuring and of the pay shoots are never co-extensive. This is proved by the exploration in depth of the three deepest mines—*i.e.*, Mills United, Brilliant Deeps, and the Brilliant Extended—where the fissures have been followed much deeper than the bottom of their lowest pay shoots. The Brilliant has proved the most persistent in depth. While notoriously patchy near the surface, one shoot was worked from near the surface, in the Victoria Mine which extended into the Bonnie Dundee Mine to a depth of 1,450 ft., while the greatest shoot of that lode, first located in the Brilliant P.C. and ultimately worked in the Victory, Brilliant and St. George, and the Brilliant Extended, proved to have a vertical range of approximately 2,300 ft. It has been followed down in the latter mine to 2,986 ft. v.d., but has become too impoverished there to continue on. The Brilliant has therefore carried payable gold over a vertical range of nearly 3,000 ft. Work has been carried on a little below the 3,000-ft. level in the Brilliant Extended without encouragement as to further payable ore. At the No. 23 level (hanging-wall), v.d. 2,986 ft., in that mine, the lode was about 5 ft. wide containing from 2 to 5 ft. of quartz but relatively less "formation" than in the higher levels. The reef at that depth has a tendency to split frequently, and includes horses of mullock, but the walls of the lode are clearly defined, and this character, and the width, indicate a continuation to a much greater depth of the lode fissure. Prospecting work in Mills United Mine has followed the fissure to a depth of about 2,700 ft.—several hundred feet below the



APPROXIMATE OUTLINE AND VERTICAL RANGE OF THE PRINCIPAL DAY DAWN AND BRILLIANT ORE-SHOOTS.

(Shown in projection on the planes of the Lodes.)

Plate 21.

bottom of the lowest ore-shoot worked there—where it has greatly diminished in size and only occasionally carries quartz which is usually very low-grade.

Of the other reefs dipping to the north the Queen has been followed to a depth of 1,330 ft. in the Queen Deeps. Most of the gold from this reef was obtained above the 400-ft. level. The Identity reef was worked to a depth of 740 ft. in the Good Hope Mine, and subsequently prospected to about 1,000 ft. deep.

Of reefs dipping east, the Victory has been worked below 1,100 ft. in the Bonnie Dundee and Queen Central mines. The Rainbow, over 1,000 ft., and the North Australian, about the same, are next in ascending order. Others—so far as data could be obtained, for workings on these belong to early days—are Old Queen Cross Reef 730 ft., St. George 650 ft., the Just-in-Time 500 ft.

The data of prospecting work on all the lodes has shown definite fissures extending below the pay shoots. All the reefs above mentioned, not including the Day Dawn and the Brilliant, were so rich at shallow depths as to warrant testing at deeper levels. If we except the Queen reef, where the fissure was followed down unsuccessfully for about 800 ft. deeper than the lowest levels of payable ore, most of the lodes show only 100 to 200 ft. of prospecting below the lowest shoots.

ORE SHOOTS.

Form of Ore Shoots.

It is seldom that lodes carry ore bodies that are equally distributed along them, and those of Charters Towers adhere to the usual rule. It has been a field of high values as gold ores go, but the pay ore has been confined to individual shoots distributed irregularly through the lodes. Between the shoots there may be no ore, but it is usual to have veins or quartz reefs carrying values below those which could be worked profitably. Necessarily the boundaries of ore shoots must be arbitrary to an extent, depending sometimes on cost and facilities of mining, for what would be worked as part of an ore shoot in one mine might, perhaps, be impossible to work in an adjoining mine where the shoot really extends. Making allowance for this, it appears that the Charters Towers ore shoots are very irregular in form, but that the majority of the more important have a much greater vertical extent than horizontal. (*See* plate 21.) As a rule, they have no definite direction of pitch, with the exception of those on the Brilliant lode and several of the reefs associated with it, in which the pitch is to the east with increasing depth. The most notable instances of this are (1) the main Brilliant shoot worked

between the Victory mine (v.d. 550 ft.) and the Brilliant Extended (2,900 ft. v.d.); (2) the Victoria shoot (Brilliant lode) worked between Victoria Mine (v.d. 100 ft.) and the Bonnie Dundee (v.d. 1,450 ft.); and (3) the Queen Cross shoot worked between the Band of Hope Mine (v.d. 750 ft.) and the New Queen Central Mine (v.d. 1,000 ft.).

Decreasing Values in Depth.

The progressive decrease of values in depth is very marked, despite a contrary opinion which is held to some extent on the field, more particularly when a small patch of rich ore, assaying perhaps 2- or 3 ounces of gold, is found in the deep-level mines. The decrease is not only in following individual shoots downwards, but shoots occurring in the lower levels have seldom, if ever, been enriched to the extent of those at shallow depths. It is not to be inferred from this that higher grade ore has not been found at the 3,000-ft. level than at the surface, but it can be affirmed that pay shoots between the surface and 1,000-ft. level were richer than those between 1,000-ft. and 2,000-ft. levels, and that these were correspondingly richer than those found below 2,000 ft. The following table, showing the average gold content per ton of most of the principal ore shoots worked, well exemplifies this, although it is only claimed that the last column is approximate in some cases, owing to occasional mixing of ores from different reefs. Tonnages of ore exceeding 60,000 in each case were involved in making calculations for that column, with the exception of the Victory Mine (24,000 tons), the ore from which represents a portion of the main Brilliant shoot, which overlapped into that leasehold:—

Table Showing Average Gold Contents per ton, of Ore-Shoots at Different Levels.

Depth.		Mine.	Lode.	Average Content of Gold Won per ton of Ore.
				Crude oz.
0-1,000 ft.	100-800 ft.	Victoria	Brilliant ...	2·4
	200-1,000 ft.	Day Dawn Block and Wyndham	Day Dawn ...	1·6
	550-750 ft.	Victory	Brilliant ...	3·4*
	700-1,000 ft.	Queen Cross	"New" Queen Cross	2·3
	760-1,000 ft.	Brilliant P.C.	Brilliant ...	1·7*
1,000-2,000 ft.	1,000-1,900 ft.	Brilliant and St. George	Brilliant ...	1·25*
	1,050-1,800 ft.	Mills United	Day Dawn ...	1·03
	1,500-1,900 ft.	Brilliant Central	Brilliant ...	0·92
2,000-3,000 ft.	2,000-2,300 ft.	Mills United	Day Dawn ...	0·87
	1,900-2,900 ft.	Brilliant Extended ...	Brilliant ...	0·55*

* Compare these figures as showing a progressive decrease in enrichment of one individual pay shoot with increasing depth. This was the largest individual instance on the field—the main Brilliant shoot.—J.H.R.

MINERALS OF THE LODES.

The minerals associated with the ore deposits are not numerous and are mostly those of common occurrence. They may be divided into two groups, comprehending reef minerals and gangue minerals.

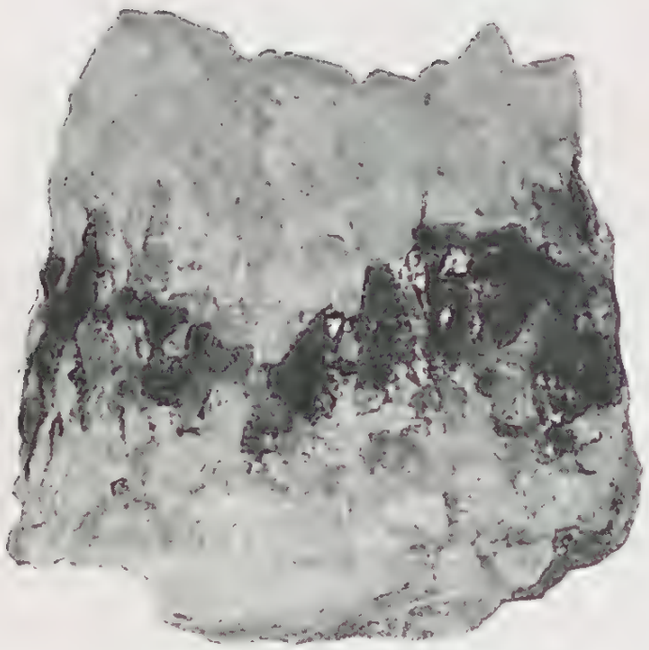
Minerals of the Quartz Reefs and Veins.

The characteristic minerals are pyrite, galena, and zincblende, following their order of abundance. They are common to all parts of the field. A few other minerals are found, but they are restricted to one or two mines and are not plentiful even there. Quartz and a little calcite are the only non-metallic minerals usually found in the reefs.

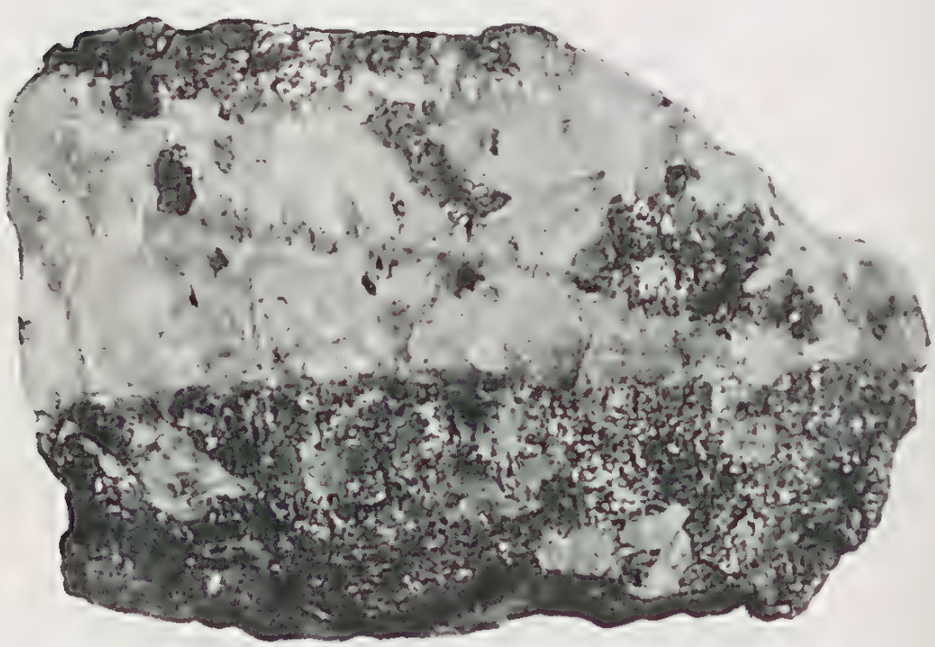
Pyrite (iron disulphide—"mundic").—This is the most common mineral of the reefs. It is practically never absent, for the patches of white quartz designated "buck quartz," which occur in all the reefs, contain small isolated bunches or grains of this mineral. It occurs massive as bunches, or in veins through the quartz roughly parallel to the lode walls, or it may be disseminated in small particles. In the former case it is rarely found without subordinate amounts of galena or zincblende. There has seldom been opportunity for the free growth of crystals, but the aggregates usually show some faces of partly developed cubes. Associated with galena and zincblende it is to be regarded as a favourable accompaniment to gold, and experience has taught the local miner to expect gold in "mineral stone." Even so, much pyritous quartz has been found unpayable, and the percentage of pyrite present is not always an indication of the amount of gold present, as may be judged from the following table, calculated from a series of partial analyses made by Mr. F. E. Connah, F.I.C., Government Chemical Laboratory, of samples collected by me. These represent averages of mineralised quartz from the reefs:—

Assay No.	Percentage of Pyrite in Sample.	Assay Content of Ore.	
		Gold per ton.	Silver per ton.
		Oz. dwt. gr.	Oz. dwt.
484	37·2	13 7 14	3 18
489	36·6	0 8 5	0 9
486	33·2	5 6 5	22 18
490	18·3	2 4 5	7 2
488	10·6	2 5 0	0 16
485	4·5	0 16 14	2 13
491	4·0	0 5 5	1 8

Plate 22.



No. 1—Vein Quartz with a Band of Zincblende (X2), New Brilliant Freeholds.



No. 2—Banded Ore (X2), Brilliant Deeps Mine—Depth, 2,700 ft. Quartz with pyrite and galena.

Galena (lead sulphide).—This mineral, as before stated, is only subordinate in quantity to pyrite, with which it is constantly associated in practically every mine on the field. In shallower ground than is now being generally worked on the field, galena was reported to be more abundant, and it is seldom that massive galena ore is now found. In taking average samples of mineralized ore, those picked especially for the galena content only assayed up to 7 per cent. of the mineral. There is much difference of opinion in the mines as to whether galena or zincblende is more favourable for the presence of gold in the reefs. Analyses prove in most instances that the percentage of galena varies with the gold content. From eight analyses made of ore from diverse parts of the field by Mr. F. E. Connah, F.I.C., the percentage of galena rises with the amount of gold present with one exception, while the zincblende percentage varies widely.

TABLE SHOWING RELATIVE PERCENTAGES OF GALENA AND ZINCBLENDE TO THE GOLD CONTENT OF ORE.

Gold per Ton of Ore.	Galena.	Zincblende.
Oz.	Per cent.	Per cent.
25·6	6·5	9·1
13·3	5·8	1·7
5·3	4·0	6·6
2·2	3·1	trace
2·2	0·3	9·1
0·8	2·9	1·2
0·4	0·9	3·6
0·2	trace	7·9

These figures are confirmed as relating to galena by the assays of concentrates quoted in a preceding chapter. Of six assays of concentrates all, with one slight exception, showed an increase in gold as the percentage of lead increased. Some of the richest shoots of the field—*e.g.*, the 948-ft. formation in the Queen Cross Mine—were noted for the amount of galena contained in the ore.

Zincblende or *sphalerite* (Zinc sulphide—"black jack").—The dark-coloured variety known as "black jack" is the only one present. The Black Jack Mines are not so named from any allusion to this mineral. It is difficult to now obtain data as to the abundance of the minerals present in vertical range, but from all accounts zincblende was not so plentiful near the surface as at depths below 1,000 ft. Below 2,000 ft. it is apparently more abundant in the ore than galena, as the majority of the samples in above table were taken from below that depth. It is, however, widely distributed, and certain reefs have been noted for its

relative abundance, as, for instance, the Brilliant footwall reef in the Brilliant Central Mine, of which the former manager (Mr. H. McKay) said it was more patchy but richer than the main reef. The maximum amount of zincblende noted in any of the ores was 9 per cent. for averaged samples of mineralized ore.

Chalcopyrite (sulphide of copper and iron) is very rarely found on the field. Assays of the sulphide ores invariably show traces only of copper. An assay of ore from the Brilliant Deeps Mine, in the stopes above No. 7 level, showed 1·3 per cent. copper, presumably present as chalcopyrite, although it can rarely be detected in specimens of ore. It has been recorded from the following mines associated with pyrite and galena:—Alexandra, Day Dawn P.C., Swedenborg, and Stockholm.

Native Arsenic.—This is recorded by Marks* as having been obtained from the Mary Lou Mine, about 3 miles south-west of Charters Towers. It was not noticed in any of the other mines.

Arsenical Pyrites (Mispickel—sulph-arsenide of iron).—This mineral is seldom found. It has been recorded from the Alexandra, Victoria, and Imperial mines. It is also stated to occur with pyrite in the Sunburst and the Brilliant Deeps mines, in the latter instance on the main Brilliant reef.

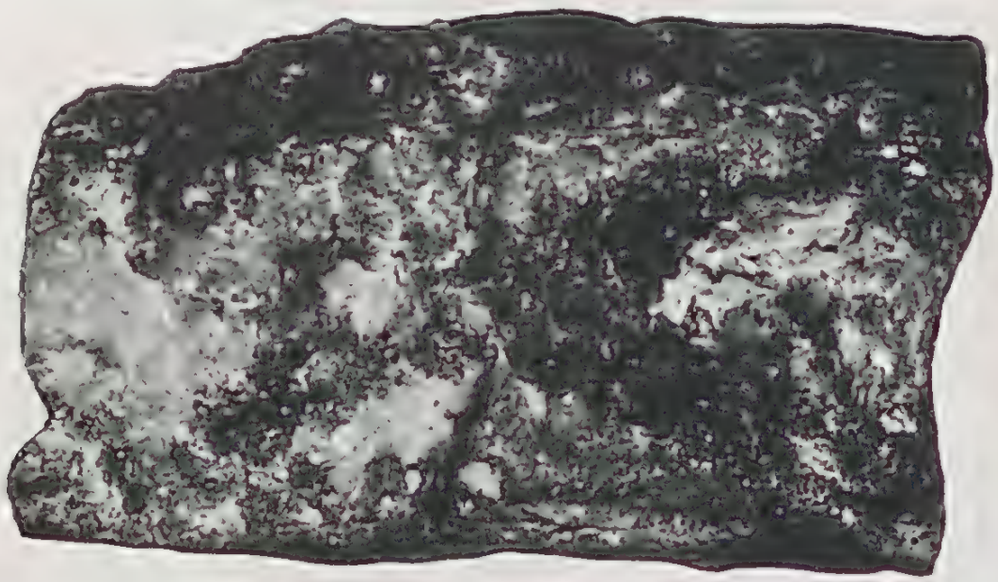


PLATE. 23.—TYPICAL MINERALISED ORE, BRILLIANT EXTENDED MINE.
Quartz with Pyrite, Galena, and Zincblende.

Tellurides of Gold and Silver.—Telluride minerals which have not been definitely determined have been found as occasional specimens in two mines only—viz., the East Mexican and the New Brilliant Freeholds. In the latter mine a small patch of coarse specimen gold, associated with telluride ore, was found in 1914 on

* Pub. No. 238. Q.G.S., p. 14.

the hanging-wall branch of the Day Dawn reef at No. 2 level at a depth of 1,522 ft. In the adjoining mine, the East Mexican, tellurides of gold and silver were found many years ago, and some of the best are now in the collection of the Charters Towers School of Mines. The Director, Mr. H. I. McGillivray, kindly consented to have tests made of portions of these for determining particularly their mineral species. Owing to the amount of free gold intermixed with the tellurides, satisfactory tests were impossible. He has kindly furnished me with the following note on the minerals:—

> The specimens in the possession of the School of Mines which show telluride of gold were all obtained from the East Mexican Mine, the localities being given as "Mexican reef" and "Day Dawn reef."
>
> The tellurides were associated with gold, pyrite, and in some cases sphalerite, in quartz.
>
> Sufficient material for a complete analysis was not available. Small fragments were assayed for gold and silver by Mr. P. Harvey by cupelling with lead. The following results were obtained:—
>
> | | *Gold.* | *Silver.* |
> |---|---|---|
> | A .. .. | 23.0 per cent. | .. 41.8 per cent. |
> | B .. .. | 8.0 per cent. | .. 45.8 per cent. |
>
> A approximates most nearly to the composition of Petzite, B to that of Hessite. Under the lens the tellurides were seen to be so closely intermixed with gold as to make these determinations of doubtful value.
>
> The material available from other specimens was even more unsatisfactory.
>
> All the specimens were of pale steel colour, approaching silver white, and of brilliant metallic lustre.

Quartz is naturally the most abundant mineral of the reefs. It varies in colour from milky white to bluish white. It is scarcely ever crystallised, but comb structure has been noted on many occasions. The bulk of poor-grade quartz is milk-white. A blue tinge is considered to be favourable for gold.

Calcite (carbonate of lime).—White calcite is commonly associated with quartz in most of the reefs, but in small quantities only.

Secondary minerals derived from the vein minerals by circulation of surface water appear to have been conspicuously unimportant.

Ironstone is recorded from the outcrop of the Just-in-Time reef, and copper carbonate from the Stockholm Mine. Oxidation of sulphides in some parts of the field, notably on the Wellington and Moonstone flats, has not exceeded 100 ft. in depth. Early

operations have left no clue as to the depth generally of the oxidised zone or the extent or nature of any secondary deposition near the surface, but the latter is believed to be almost negligible.

Gangue Minerals.

The gangūe of the ores consists of decomposed grano-diorite and secondary minerals mainly formed therefrom or from intersecting dykes. These comprise pyrite, calcite, steatite, gypsum, chlorite, barytes, zoisite, sericite, and epidote. Of these only pyrite and calcite are very abundant.

Pyrite.—Small crystals and grains of pale brass-coloured pyrite are plentifully besprinkled through the gangue of all the lodes. Crystals are usually developed—particularly on walls or joint faces—as cubes modified by pyritohedral faces. Microscopically, they are seen to be abundant, more so where the alteration of the rock is great.

The gangue seldom contains more than a trace of gold, and the pyrite probably contains not more than a trace of the metal. The physical distinction between the pyrite of the reefs and the gangue is marked in all instances, and the mineral is less concentrated in the latter. The often complete elimination of the ferro-silicates of the original rock points to the pyrite as an ultimate product of them.

Calcite.—As a replacement, calcite is very abundant, both in relatively large masses and in small grains permeating the gangue, as seen under the microscope. In the lodes where dioritic rocks are present it is particularly abundant.

Gypsum.—R. L. Jack, in his report of 1879, has recorded the occurrence of this mineral as veins on the sides of a dioritic dyke in the North Australian Mine, and also in the Queen reef, above a depth of 200 ft.

Barytes.—The same writer refers to barytes as occurring on joints in granite walls in the Old Identity Mine.

Mineral Paragenesis.

A uniformity which marks the distribution of pyrite, galena, and zincblende over the entire field, and is apparently almost equally marked in their vertical range, points to only one long phase of deposition of the ores. These sulphides are seldom present without some trace of one another, and it seems impossible to establish any definite sequence of mineral formation. The evidence suggests that the solutions contained the three sulphides in varying proportions during the whole period, and that their deposition synchronised.

ORE GENESIS.

Origin of the Ores.

The principle of vein formation by aqueous solutions is so universally held that there is no need to go beyond the statement that every point of evidence completely sustains the assumption of deposition of the ores from this source. Foremost amongst this evidence is the replacement of crushed rock by the quartz of the reefs, the crustified character of small veins between hard walls, and the character of the minerals deposited.

NATURE OF THE SOLUTIONS.

The composition of these solutions may be approximately arrived at by a consideration of the reef minerals and the alteration of the wall rock. The former consist of quartz, gold, pyrite, galena, zincblende, chalcopyrite, arsenopyrite, tellurides of gold and silver, and calcite. It is to be noted here that these are, both for metallic and gangue minerals, those stated by Lindgren to be characteristic of deposits formed at intermediate depths by ascending thermal waters and in genetic connection with igneous rocks.* The temperatures at time of formation are considered by him to range from 175° C. to 300° C. under a pressure of from 140 to 400 atmospheres. The elements concerned in the formation of the above list comprise silica, calcium, iron, lead, zinc, copper, gold, tellurium, sulphur, arsenic, carbon, and oxygen. From the replacement of lode rock (grano-diorite), the vein-forming solutions must have received increments of silica, iron, lime, and alkalies. The presence of calcite both in the veins and wall rock, and of sericite in the latter, indicate that carbon dioxide or alkaline carbonates were probably contained in the solutions. The general character of the ascending waters appears to have been predominantly siliceous, with smaller but notable percentages of hydrogen sulphide, alkaline carbonates and certain base metals, while some of the alkalies, iron, and silica were probably derived from the lode-rock and wall-rock by reaction with the primary solutions.

SOURCE OF REEF- AND VEIN-FORMING MATERIALS.

In so far as the ores at Charters Towers are confined solely to igneous rocks, usually at some distance from rocks of sedimentary origin in which quartz-veins have proved non-auriferous, and that the deposits are in no sense contact deposits, the problem of the derivation of the gold and accompanying minerals in the reefs appears to be reduced to either the process of leaching by underground water from the enclosing rocks or

* Mineral Deposits. W. Lindgren, p. 514.

deposition from aqueous solutions or vapours having a common origin with some of the igneous rocks occurring in or adjacent to the auriferous areas.

With regard to the question of leaching by underground water from the enclosing rock (grano-diorite), the evidence is of a negative character, and the following data is mainly relied upon in reaching that conclusion.

(*a*) Narrow zone of alteration outside lodes.

(*b*) Comparative poverty of grano-diorite in gold and primary pyrite.

(*c*) Presence of barren quartz veins in auriferous belts in grano-diorite.

(*d*) Absence of circulating underground water in some of the deep-level mines.

(*a*) Lindgren and others have pointed out how inadequate is the theory of meteoric waters leaching from a relatively narrow zone of altered rock adjacent to fissures, sufficient gold and sulphides to account for that found concentrated in many veins. The observation appears to apply to the Charters Towers field, for there is practically no evidence of other than slight alteration outside of several feet of the lode walls. Numerous crosscuts from the lodes have afforded means of observing this. Sections of rock taken from near different lodes to depths of 2,000 ft. show little alteration of the ferro-magnesian minerals, although felspars always show a slight degree.

(*b*) Assays, made with extreme care as to method, utensils, and fluxes, by Mr. F. E. Connah, F.I.C., of grano-diorite from the East Mexican Mine and from an outcrop in Drew street gave in each instance the following result:—

Gold:—0.20 grains per ton of rock.
Silver:—Nil or trace.

Don has isolated biotite and hornblende from grano-diorite from the 1,070-ft. level, Brilliant and St. George Mine, and the results of two analyses of each of these minerals for sulphides, gold, and silver show none of them to be present.*

Sulphur (present as sulphide) in grano-diorite from the East Mexican and New Queen Central mines, in each instance returned 0.02 per cent. while in a series of six rock sections no pyrite was seen under the microscope. The diorite-porphyrite dykes intersected by the lodes contain relatively abundant pyrite, but the great majority are under 3 ft. thick, and from their volume would be an inadequate source of sulphur.

*The Genesis of Certain Auriferous Lodes. J. R. Don. Trans. Amer. Inst. of M. E., vol. xxvii., table xviii.

Of four assays of these dyke-rocks, made under similar conditions to those of the grano-diorite, three samples contained neither gold nor silver, while the other contained 0·18 grains of gold per ton of rock. Neither the grano-diorite nor the dyke-rocks—the latter on account of their small volume—appear to contain sulphides which could have yielded the necessary sulphur for the sulphides concentrated in the lode channels.

(*c*) As is noted elsewhere, barren quartz veins occur occasionally, faulted by the lodes. These consist of white quartz devoid of galena, zincblende, and gold, but contain occasional grains of crystallised pyrite. As they are cut by lodes carrying the sulphides and gold, it is necessary to assume another source than leaching for them, for leaching of the same enclosing rock would not account for the differences in composition.

(*d*) In some of the deep-level mines it is undoubted that the lodes were perfectly dry in many parts when first opened up. This may seem at variance with the figures relating to water raised from mines in subsequent years, but most of the mine workings are connected now, and the water in the deep mines has drained from those nearer the surface, where it was not impounded. Again, heavy flows are occasionally struck at great depths from large joints intersecting the country rock and the lodes. These are not many, but several were noticed in the Brilliant Deeps lower series of workings and one in the Bonnie Dundee No. 2 shaft workings (cut some years ago in a crosscut) quickly flooded the shaft for some hundreds of feet. The Brilliant lode in the Brilliant Deeps was an instance of the dryness of some lodes in depth, for when the underlie and levels were first opened up at a depth in the region of 2,400 ft. there was reported to be no soakage. At the present time many of these workings are dry, despite the fact that the lode immediately above has not been worked, in which case percolating water might be diverted to other mines.

The evidence as to the genetic connection of the gold and reef minerals with a rock magma appears to substantiate the statement that they are products of the dioritic magma from which the diorite-porphyrite dyke rocks, and probably the other diorite rocks of the field at earlier periods, were derived. The data in support is—

(*a*) The occurrence of the bulk of the gold ores in proximity to the principal groups of these dykes.
(*b*) Relative abundance of pyrite in the dyke rocks.
(*c*) Tellurium in the lodes.
(*d*) Primary form of ore shoots.
(*e*) Enrichment below groundwater level.

(*a*) In considering the distribution of the ores it was stated there were two main auriferous belts trending from north-east to south-west and that outside of these there were isolated deposits of payable ore. It has also been shown that there are at least two series of intrusive dykes, the older series striking north-east to south-west and the younger from north-north-west to south-south-east. In the main auriferous belt, which has supplied probably 90 per cent. of the total gold yield, and which includes the Day Dawn, Brilliant, and the reefs associated with them, the older dykes are numerically in strong force, and it is to be noted that they have a similar trend, not to individual ore shoots, but to the auriferous belt. Of all the mines examined in this belt only those on the eastern extension of the Brilliant and just to the south of that area appear to be free from these dykes. It has to be stated here that these mines worked some of the richest shoots on the field, including the famous Queen Cross shoot, and this has led to the belief on the field that the intrusive dykes have no connection with the formation of the ores. These dykes are particularly abundant on the areas known as the Moonstone and Wellington Flats, where very rich ore has been, and is being, mined. The same series has been traced almost continuously to the Day Dawn lode, which intersects them over a distance of approximately a mile, a length which includes all the famous shoots of the Day Dawn P.C., Day Dawn Block and Wyndham, and Mills United, the three richest mines on the Day Dawn lode. Further, these dykes have been picked up in the Brilliant lode workings and traced as far easterly as the western boundaries of the Brilliant Extended and the Brilliant Central mines. East of this none of these dykes could be found underground. The great majority of the mines to the east and south were closed, but those working at the time, which included the Bonnie Dundee, New Queen Central, New Queen Tribute, and the Victory were examined. From data gathered from former mine managers no dykes were found in the group which includes the Victoria, Band of Hope, Queen Cross, and the Caledonia mines. From the size of one dyke—20 feet thick—found passing through the workings of the Brilliant Deeps and Brilliant Block mines and never traced further east, there is a possibility of a big fault prior to the formation of the lode fissures, of which no other evidence has been found, occurring in the vicinity of these mines and the Brilliant Extended. This may account for the sudden disappearance of the dykes in the area just mentioned. South of the main belt, a tract of almost non-auriferous country about three-fourths of a mile wide intervenes before the minor auriferous belt is reached. This tract is devoid of the older diorite-porphyrite dykes as far as the surface shows, but is crossed by occasional groups of the

"Pfeiffer's Gold Mines"
"Mills Day Dawn United"
"Brilliant Deeps"
Brilliant Block Mill
St George Ck
DAM
New Queen Mill
"Brilliant Extended"
"Day Dawn Block & Wyndham"
Day
Dawn
Enterprise Mill
No1
No2
"Brilliant Block"
"Bonnie Dundee"
To Townsville
"Brilliant Ext.a"
"Bonnie Dundee North"
Clark's Gold Mines
North Australia
Mills Day Sh
"New Brilliant Reynolds"
"Day Dawn P.C."
Mexican
"East Mexican"
Reef
Lode
"Brilliant"
St George "Kelly's" Queen Block
Brilliant Con
STATION
Main Sh
No3
New Queen Central
Brilliant C Sh
Phoebe
"Queen Tribute"
Queen Lode
Queen Central
"Kelly's Welcome & Union Leases"
Kelly's Sh
Union
Welcome
Reef
"Clark's Gold Mines"
Reservoir
No4
No1
No2
Victory Reef
"Victory"
No2 S.E. Day Dawn
No2
No1
"Clark's Brilliant Worcester and Victoria"
Brilliant
Queen Cross Sh
Just-in-Time Reef
"Just-in-Time"
Band of Hope
Papuan Brilliant Victoria
Victoria
No2
Clark's Moonstone Reef
Papuan, Brilliant & Victoria
Moonstone Reef
Moonstone & Telegraph
Tower's Hill
Rainbow Reef
Rainbow Mill
"New Queen Cross"
Victoria No1 W
"Victoria"
"Vic & Cal Block"
"Victoria & Queen"
Lode
Rainbow Cyanide Works
"Craven's Caledonia"
"Millican's Caledonia"
Madelaine
"St George and Moonstone"
"Carrington"
Queen Cross Mill
DAM
Wellington Reef
Iron Duke Sh
Nagles
Ck
ST NORTHERN Ry
Excelsior Mill
Millchester
Golden Surprise Reef
Ck
"Ruby P.C."
"Ruby United"
"Ruby"
Hornblende-porphyrite Dykes
"Good Hope"
Venus Mill
Ck
"Ruby and Macdonald Unit"
"Ruby S"
"Ruby United E"
"Ruby No1 E."
Identity Unit
"New Grace Darling"
Identity Lode
Gladstone
Mill
Mary Lou Ut
Mary Lou P.C.
Mary Louisa Workings

Reference

G.M. Leases in force.
cancelled
Ore Shoots (principal)
Diorite Porphyrite Dykes
Lodes and Reefs.

Scale of Chains.
0 8 16 24 32 40
FB

younger dykes. The minor belt includes the Identity group, Ruby, and the Mary Lou mines, the two former being payably worked in the past. A line drawn through these approximates to the trend of the older dykes, and from the Mary Lou to the vicinity of the Ruby a narrow belt of country contains a large number of these, as many as twenty-four being counted in a width of 18 chains. These could not be traced on the surface to the Identity mines, but it is noteworthy that dykes with a close chemical and mineralogical affinity to the others are conspicuous in that mine. This group of dykes is in marked contrast to the dykeless and almost non-auriferous character of the country immediately to the north-west and south-east.

In all the isolated mines where payable gold was found, such as the Alexandra, Stockholm, Imperial, Cumberland, Black Jack, and others, the dioritic dykes are found associated with the ore or there is surface evidence that they are in proximity thereto. While isolated dykes, probably belonging to either of the two series, can be found over most of the area examined, it seems a significant fact that the dykes intersecting the main auriferous belt are so numerous that they outnumber all others of the same series found on the field and, likewise, those in the minor auriferous belt are numerically the next important.

(*b*) In contrast to the grano-diorite the porphyrite dykes of both series contain relatively abundant pyrite as a primary mineral. This was noticed in all sections examined under the microscope. In the rock analyses the percentages of FeS_2 are given as follows:—Bucklands Hill diorite 0·56; older porphyrite dykes 0.46; younger porphyrite dykes 1.16. As against these both analyses of the grano-diorite give 0.02 per cent. of S (as sulphide), equal to 0·037 FeS_2. The relative abundance of sulphur and iron in the dioritic magma indicates it to be a possible source of the pyrite, which is the most abundant metallic mineral of the reefs, as an emanation therefrom.

It is perhaps worth noting that the percentage of FeS_2 in the younger dyke series is in the ratio of 2·5 to 1 to that in the older series, so that it may indicate increasing metallic concentration during differentiation of the magma. This, of course, needs confirmation by a series of determinations of FeS_2 in further specimens of the two series.

(*c*) The presence of tellurium in several of the reefs is also in favour of a genetic origin from magmatic waters. Almost all the tellurium deposits of the world are associated with igneous rocks. Literature furnishes little definite information as to its

source. At Cripple Creek, Lindgren and Ransome* after discussing the probable source of the tellurides there, fall back on the conclusion that they emanated from a cooling magma under influence of diminishing pressure. At Kalgoorlie, Larcombe shows the primary origin of the tellurides by simultaneous deposition with silica during first concentration from deep seated solutions.† He, however, does not make a definite statement as to the source of the water, but says the application of the magmatic theory has much in its favour to account for ore deposition there.‡

(*d*) According to Lindgren§ primary shoots are characterised by the predominance of the vertical extension of the shoot as opposed to horizontal extension in vadose shoots. In the principal ore shoots in the Brilliant and the Day Dawn lodes the vertical extension is much greater than the horizontal. (*See* plate 21.)

(*e*) It is the consensus of evidence in the mines on the field that there is very heavy surface water to a depth of about 300 ft. After that depth is exceeded little trouble is experienced with water. Two of the richest shoots of the field occurred between depths of 500 and 1,000 ft., and there are numerous instances of local enrichment of the lodes between depths of 2,000 and 3,000 ft. where there is no general circulation of underground water.

Deposition of the Ores.

The causes underlying the deposition of the ores is of importance, but a review of the evidence, which is in some cases in conflict, does not lead to any definitely established conclusion.

Almost the whole weight of evidence from the mining regions of the world shows that deposits of this nature were precipitated from aqueous solutions under conditions of high temperature and pressure. Unfortunately, chemical reactions under these conditions are yet imperfectly understood. The precipitation of ores from solution may be brought about by—

(1) Changes of temperature and pressure.
(2) Change in chemical composition due to—
  (*a*) the addition of some substance to the solution;
  (*b*) the loss of some substance from the solution.

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* Geology and Gold Deposits of Cripple Creek. W. Lindgren and F. L. Ransome. U.S.G.S. Prof. Paper No. 54, p. 225.

† Geology of Kalgoorlie. C. O. G. Larcombe, p. 158.

‡ *Ibid.*, p. 226.

§ Mineral Deposits. W. Lindgren, p. 171.

In ore deposition in mineral veins the chemical changes mentioned are usually brought about by reactions between the solutions and wall rock, solutions and gases, or by the intermingling of distinct solutions.

INFLUENCE OF COUNTRY ROCK.

The composition of the country rock, grano-diorite, particularly over the main auriferous belt, is fairly uniform. Specimens of the rock from many different parts of the field, including the Day Dawn and Queenton areas, have been sectioned and examined. They were obtained from near the surface and at various depths down to 2,000 ft. The examination of them confirmed what had previously been noted in all mines except one, viz., that there was no visible change in the character of the country rock either in the rich or poor sections of the auriferous belt. The only changes are where a quartz diorite, rich in hornblende and poorer in quartz as compared to the normal country rock, replaces the latter. This is seen in Clark's Gold Mine, where both rock types enclose rich and poor veins. The Day Dawn lode has opened up in part of its course along a dioritic dyke, but the lode is highly payable and also impoverished in contact with it. The mine where the dyke is most in evidence—the New Brilliant Freeholds—has been poorer than a number of the other mines that worked that lode. The presence of that dyke rock has not assisted ore deposition, for equally rich or perhaps richer shoots of similar ore have been met with in the Queen Cross Mine, where there is no diorite.

The pay shoots occur very irregularly, but there is no change of country rock to account for the sudden changes from enrichment to impoverishment of the lodes.

INFLUENCE OF INTERSECTIONS.

Intersections with the two systems of lodes are made by—

(1) Aplitic dykes (earlier).
(2) Diorite-porphyrite dykes (earlier).
(3) Barren quartz veins (earlier).
(4) Faults, some with quartz veins (later).

Intersections with aplitic dykes were seldom seen, although surface mapping showed them frequently. From the evidence of their intersections, their areal distribution, and their relative age, they appear to have had no genetic connection with, or influence in, the deposition of the ores.

The diorite-porphyrite dykes run abundantly through the rich and poor sections alike of the auriferous belts. They could

only have caused precipitation by absorbing a constituent of the solutions or, as they were replaced, by contributing fresh substances to them. In either case, enrichment might be expected along, or adjacent to, the lines of intersection. No such enrichment occurs, and the pay shoots show no relation whatever to the lines of intersection. This is well exemplified in the Day Dawn lode, where approximately one hundred dykes are known to intersect.

The barren quartz veins are not abundant, and belong to an earlier epoch, judged by the fact of their being faulted by the lode fissures and the almost total absence of metallic minerals. In the Brilliant Central and Brilliant Extended there is a prominent vertical "buck" reef striking north-west to south-east. In the No. 4 hangingwall level and No. 6 footwall level, Brilliant Central Mine, it averaged 2 ft. thick, and contained small isolated bunches of crystallised pyrite.

Fault intersections were noted frequently, and have resulted mostly in but slight movement of the lodes. These are apparently most abundant in the Queenton area, as the plan workings show, but could not be investigated in most of the mines, some of which have been closed for a number of years. That slight faulting of later date than the formation of the lode fissures is prevalent over the greater portion of the main auriferous belt is borne out by the following facts:—In Clark's Gold Mine three vertical faults observed in 426-ft. level west of underlie shaft, movement from a few inches to 2 ft.; frequent faulting of diorite-porpyrite dykes in railway cutting near Rainbow road; two small faults observed in the Victory Mine, and three in the Moonstone-Telegraph Mine; also the large number of faults without appreciable lode movement shown on the working plans of the Queenton mines, now closed down.

In considering the effect of these fault intersections on the deposition of the ores, the following evidence is available:—

In Clark's Gold Mines very high-grade ore has recently been won in proximity to the faults in the 426-ft. level, but a gradual decrease in tenor away from the faults is not apparent. The downward extension of the ore along the faults is not known owing to the little depth attained.

In the Victory Mine there have been two instances of rich shoots in proximity to small faults—viz., Tuckett's and Morris's reefs. The former was exceedingly rich, crushings averaging 4½ oz. gold per ton. The workings, however, were not accessible for examination.

In Clark Worcester Mine four reefs have been worked. Only one corner of the lease proved to be payable, and the ore shoots in the four reefs almost coincided in position vertically above one another. Three slight, almost vertical faults intersect the reefs here, and the shoots did not persist more than 100 ft. from any one of the faults. Here, it appears, vertically ascending solutions traversing the faults caused the enrichment of the reefs by chemical reactions set up, or else supplied the gold and metallic sulphides.

In the Moonstone-Telegraph Mine three slight faults hading from the vertical to 70 deg. have cut the Telegraph vein, but no enrichment has occurred.

It is not known to what extent large ore shoots such as these stoped out in Mills United, Brilliant P.C., Brilliant and St. George, and the Queen Cross mines may have been affected by fault intersections. Some of these workings were inaccessible, and the heavy timbering, often reinforced with mullock, effectually hides any traces of slightly faulted walls in those that can be inspected.

In the chapter on faulting it was stated that besides the small faults there were three known of greater magnitude of movement—viz., the Caledonia, Bonnie Dundee, and the Brilliant Central faults. Reviewing the evidence of these *seriatim* it will be seen that there is evidence of enrichment along portions of them. The Caledonia fault, inclined at 70 deg., faults the Caledonia and the Victoria and Queen reefs. In the three mines, Craven's Caledonia, the Victoria and Caledonia Block, and the Victoria and Queen, rich shoots of ore were worked on both sides of the fault, in the two reefs, for nearly 600 yards along its course, but with intervening patches of lean ore close to the intersection. Fifty feet on either side the reefs became poor. The best ore was obtained between the depths of 300-and 550 ft. On a field showing such a great range in depth for high-grade ore it appears rather a chance circumstance that the fault cut a shoot of such limited dimension along the line of intersection as this, than that the fault fissure was responsible in any way for the enrichment.

The Bonnie Dundee fault, judged from the plans, is apparently vertical, and the throw approximately 10 ft. The greatest evidence of enrichment is along the faulting of the Brilliant reef. Elsewhere poor in this lease, from a shoot of ore between No. 1 and No. 4 levels and 200 ft. wide on either side of the fault, dividends were paid amounting to £21,000. The fault

turns westerly into Marshall's Queen Mine, and on the boundary further rich patches of ore were discovered along its course. The rich ore was, however, not continuous.

Two faults were seen in the Brilliant Central Mine, one in the eastern ground inclined east at 35 deg., and the other, to the west of main underlie shaft, is vertical. In the former instance there has been no enrichment. In the latter, the reef on the eastern side is thrown up 9 ft. This fault trending to the north-west was traced into the Brilliant Extended Mine, and located a little west of No. 2 underlie shaft. On the western side of the fault, the Brilliant reef has been consistently payable, and in parts very rich, between the depths of 1,500 ft. and 2,200 ft. On the eastern side the ore was of less value, and in the Brilliant Central Mine did not pay to stope. As the strike of the fault is transverse to the pitch of the shoot in the Brilliant Extended it has there had no influence on ore deposition.

CONCLUSIONS ON ORE DEPOSITION.

It seems an established fact that any changes in the character of the enclosing wall rock have not affected deposition. Reaction on the wall rock by ascending solutions does not account for the fact that pay ore is often frozen on to walls which show no evidence of special alteration, nor for the alternation of pay shoots and unpayable quartz (in grano-diorite showing little or no mineralogical change) indifferent to the degree of alteration of the walls.

Intersections of igneous dykes with the lodes have not assisted deposition.

In a number of instances enrichment of the reefs occur adjacent to approximately vertical faults, and in other instances it is the reverse. Again, with regard to the principal ore shoots of the field, there is no evidence available, owing to the circumstances of mining. However, from the instances known it is not likely that chemical reactions alone, following the mixing of solutions from the vertical faults and the lode fissures, deposited the gold and sulphides; if so, it is likely the ore shoots would follow the intersection lines with great persistency and decrease in value laterally. From the fact that slight faulting is prevalent where there has been much enrichment, and that some of these faults contain veins of ore similar to that in the lodes (*e.g.*, in the Brilliant Central Mine), it seems probable that they may have been partly, or even wholly, the channels which carried the auriferous solutions from the dioritic magma to the lodes, the deposition of which depended on other factors,

such as varying temperatures and pressures, which in some cases only may have been favourable for immediate deposition, thus accounting for the limited and irregular distribution of ore shoots noticed along the intersections of the faults. This feature might also be accounted for by a varying composition of the solutions in the lode channels. In the absence of geological data to definitely account for the distribution of the ore shoots in the lodes, it is probable that varying temperatures and decreasing pressure were important factors.

SUMMARY.

The principal ore deposits are confined to a small area, the main auriferous belt being 3 miles long by three-fourths of a mile wide. Outside of this and a very subsidiary belt there are a large number of individual mines scattered over the field, very few of which have produced important amounts of gold.

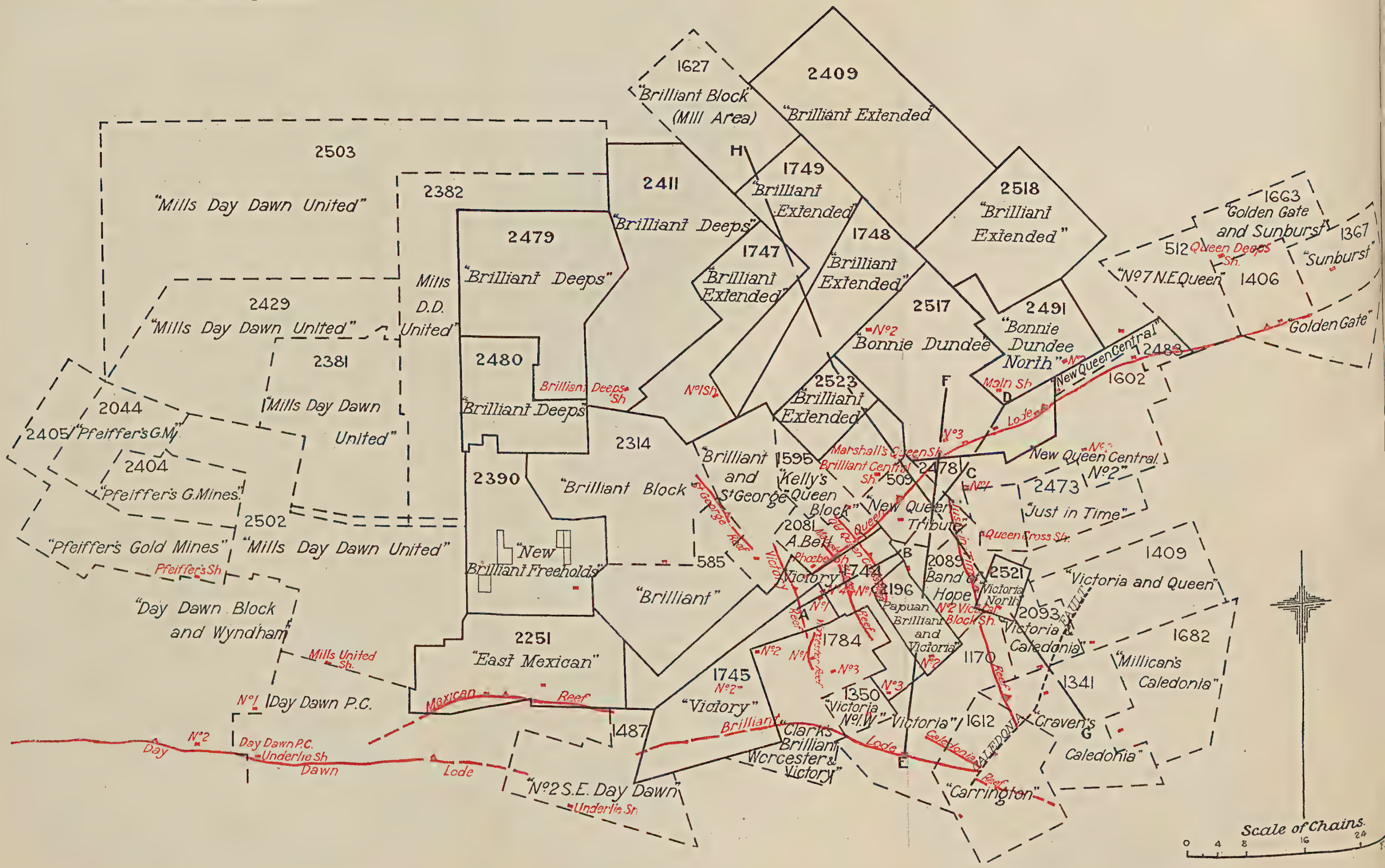
The ore deposits occur largely in composite fissure lodes—*i.e.*, lodes in which there has been repeated faulting. Most of the lode fissures have a low angle of dip, the majority under 40 deg., while the Day Dawn—the steepest—averages about 50 deg., but attains in places a dip of 65 deg.

The payable ore occurs in irregularly distributed ore shoots, and much of the quartz in the lodes is of low grade. The ore shoots are primary in form—*i.e.*, the vertical extension is greater than the horizontal. While there has been local enrichment at depths exceeding 2,000 ft., the majority of the ore shoots, and also the richest, occurred between the surface and 1,500 ft. deep. There is a marked decrease in the value of shoots in increasing depth, and the abandonment of operations in many mines has been caused through impoverishment of the lodes in depth rather than decreasing size of the lodes. The minerals associated with the gold in the lodes are chiefly pyrite (mundic), galena, and zincblende (black jack). The ores appear to have been deposited from solutions or vapours given off from the molten reservoir (magma) of igneous rocks which are associated with the lodes. About 90 per cent. of the gold production of the field has come from a small area in which diorite-porphyrite dykes, derived from this magma, are more abundant than over the remainder of the entire field. These dykes are the richest of any unaltered igneous rocks on the field in pyrite, which is the most plentiful constituent of the lodes, excepting quartz. In addition to the foregoing data, the form of the ore shoots, the character of the minerals, and the great depths at which they have been found, point to their origin being a deep-seated source in genetic connection with igneous rocks.

No definite geological evidence can be presented as to the irregular distribution of the ore shoots—*i.e.*, as to the causes underlying the deposition of ore resulting in enrichment of certain portions only of the lodes. The ore shoots are quite independent of any change in the character of the country rock or to the intersections made by igneous dykes in the auriferous areas. Enrichment has often occurred along more recent fault fissures, but in more cases it appears to have been the reverse. From the facts that these fault fissures are prevalent over the main auriferous belt and that some of them contain veins of quartz and sulphides similar to the ores in the lodes, it is very probable that they were channels supplying auriferous solutions to the lodes in which the deposition of the gold and accompanying sulphides depended to a great extent on decreasing temperatures and pressures.

Plan 1.

Principal Gold Mining Leases.



Chapter VII.

THE MINES.

Where possible detailed descriptions of all mines and important workings are included in the following pages. In the case of mines closed down for some years the data obtainable are often somewhat scant. The historical notes of the mines are mainly based on old official reports and the "North Queensland Register's History of Charters Towers." The statistics relating to production were obtained from the Warden's returns published in the Annual Reports of the Mines Department. Plans of the underground workings of those mines which are at present in operation or have recently been worked are given. In addition several others of particular interest have been included, but it was found impossible in the limits of this report to give plans of all the numerous mines closed down. Many of these will be found on the 2nd edition of the Geological Map by Jack, Rands, and Maitland, published in 1897 (see list of literature). The following table shows the aggregate tonnage, production, and dividends of the principal mines of the field arranged in order according to the total value of their output.

TABLE SHOWING PRODUCTION OF PRINCIPAL MINES.

Mine.	Period.	Ore Raised.	Gold	Value of Concentrates and Tailings.	Dividends.
		Tons.	Crude oz.	£	£
Day Dawn Block and Wyndham	1883-1912	589,531	546,871	23,905	892,962
Mills D. D. United	1890-1916	507,428	428,429	410,701	667,500
Brilliant and St. George	1892-1914	371,088	462,296	67,493	787,800*
Brilliant (P.C.)	1889-1916	340,582	403,198	5,242	680,416
Day Dawn P.C.	1881-1913	275,128	379,859	8,854	638,000
Brilliant Extended	1894-1916	567,500	202,188	475,505	150,000
Queen Cross	1890-1910	138,125	287,039	8,062	653,466
Brilliant Central	1892-1914	245,477	215,523	37,763	294,166
Victory	1881-1916	98,803	216,360	18,984	305,925
Victoria	1887-1902	70,913	146,968	...	259,000
Brilliant Block	1892-1916	158,606	133,988	1,141	81,250
New Brilliant Freeholds	1894-1916	124,360	92,537	131,978	135,000
New Queen	1889-1907	106,366	121,515	2,059	57,617
Kelly's Queen Block	1892-1913	91,586	113,937	17,575	200,200
Band of Hope	1887-1912	86,454	104,637	4,341	111,400
Stockholm	1875-1916	97,667	64,894	114,387	‡
Bonnie Dundee	1881-1916	59,296	70,808	17,277	34,685
Papuan, Bril. and Vic. (Queenton)	1887-1916	41,354	70,559	2,650	80,000
Victoria and Queen	1893-1910	35,730	63,613	1,075	66,225
Golden Gate	1888-1896	35,303	56,626	...	66,000
Day Dawn Gold Mines	1899-1904	51,937	54,120	...	70,488
Victoria and Caledonia Block ...	1899-1911	36,849	49,906	3,703	63,600

* Not including £75,000 previously paid by mines working the St. George reef at shallow depth.
‡ Not available.

MINES ON THE DAY DAWN LODE.

During 1916 only four mines were working in this group, viz.: Mills' Day Dawn United (on tribute), New Brilliant Freeholds, Redmond's Brilliant Freeholds and Day Dawn, and the East Mexican.

Mills' Day Dawn United Mine.

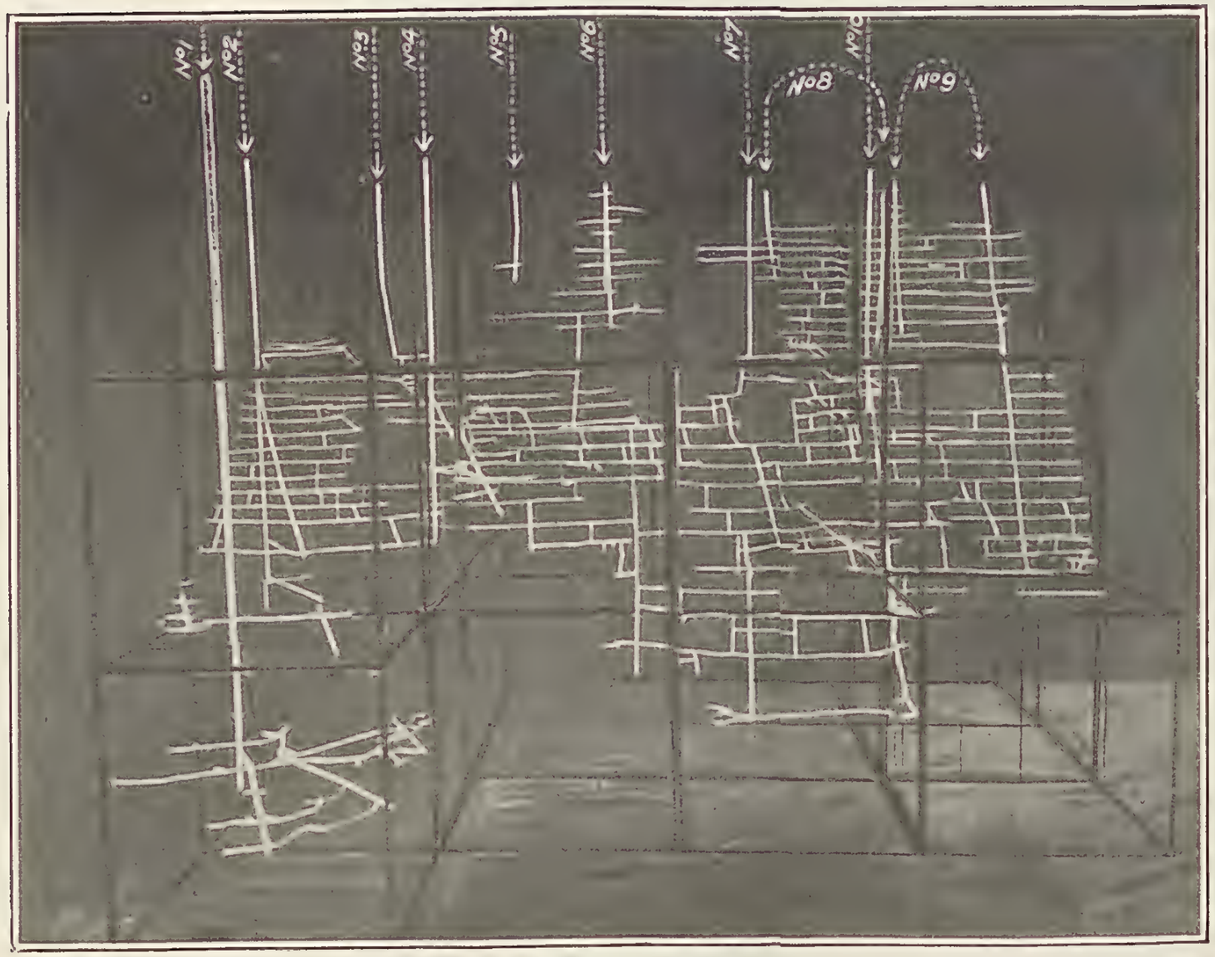
Situation, Leases, &c.—The mine is situated near the centre of the city area. The underground workings extend from Towers street to the north of Gill street and are comprised mainly in G.M.L. 2519. The shaft head is connected by rail to the main railway line and the ore was sent direct to the Company's mill at Sellheim. Prior to the recent applications for larger areas under the Mining Act Amendment Act of 1914 the Company held four leases, aggregating an area of 183 acres, forming a block on the Day Dawn P.C. and the Day Dawn Block and Wyndham Mines. The Company at time of closing down held G.M.Ls. 2503, 2508, 2509, and 2519, a total area of 299 acres.

History and Production.—The land where the shaft is situated was secured as a lease by Mr. Thomas Mills in the early

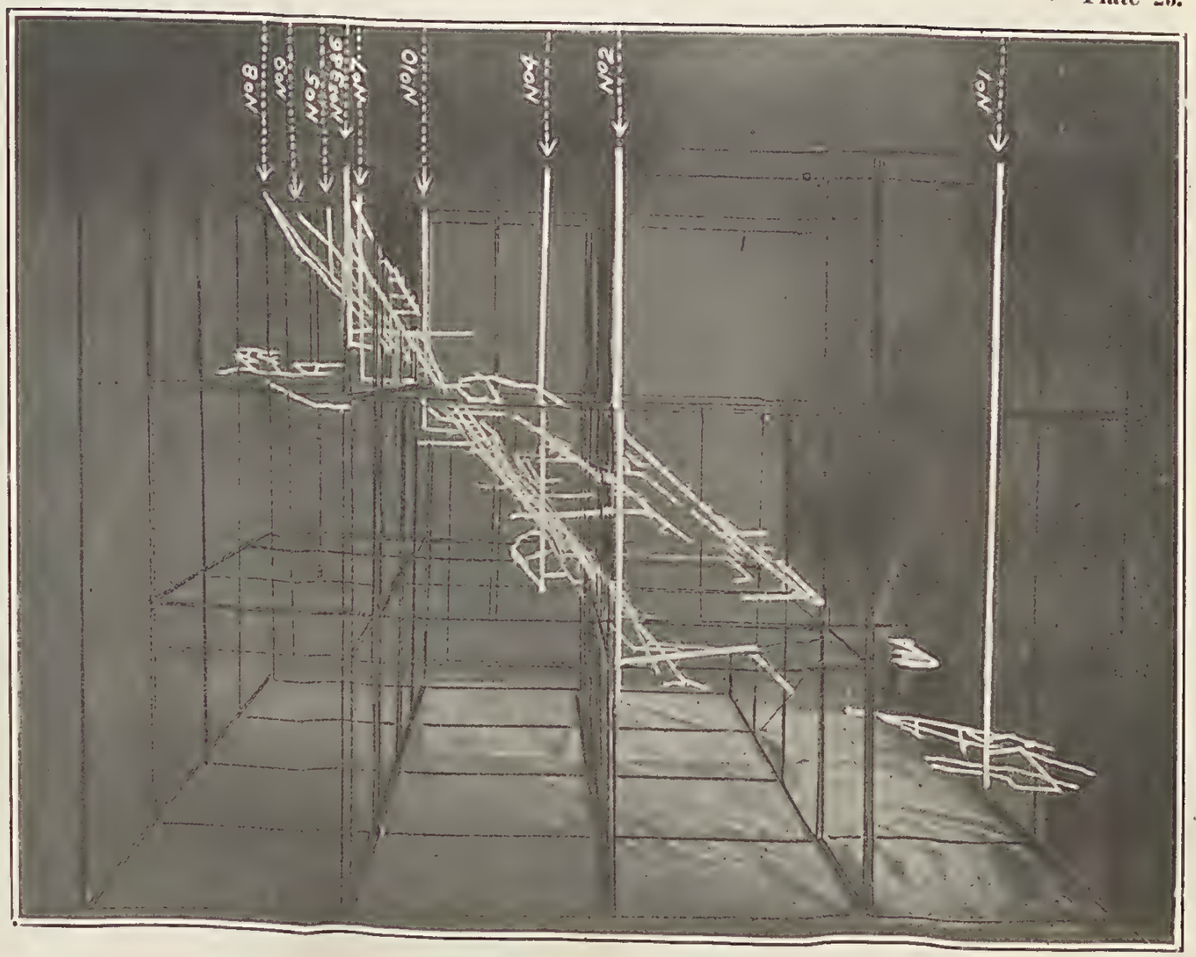
Plate 26.—Mills Day Dawn United Mine.

To end of 1916: Ore raised 507,428 tons, value £1,879,971; dividends, £667,500.

eighties. The vertical shaft to cut the Day Dawn lode was started in 1884. The shaft bottomed on a poor reef. The first



LOOKING FROM THE NORTH.



LOOKING FROM THE EAST.

VIEWS OF MODEL OF UNDERGROUND WORKINGS ON THE DAY DAWN LODE.*

INDEX TO SHAFTS.

1. *Brilliant Deeps.*
2. *Brilliant Block.*
3. *Great Eastern.*
4. *New Brilliant Freeholds.*
5. *East Mexican.*
6. *Mexican.*
7. *School Reserve.*
8. *Day Dawn P.C.*
9. *Day Dawn Block and Wyndham.*
10. *Mills's Day Dawn United.*

* Model constructed by E. O. Marks, late Assistant Government Geologist.

crushings were obtained in 1889, but only averaged 6 dwt. per ton. With the sinking of the underlie shaft and extension of the eastern levels an ore-shoot was met trending obliquely to the north-west on the dip of the lode. It was this shoot in conjunction with the Talisman reef, a branch of the main lode, that furnished the ore from which dividends amounting to £292,500 were paid in the ensuing five years. Between the years 1891 and 1895 the mine was the largest producer of gold on the field. This shoot was practically exhausted in 1896, and then followed seven lean years of prospecting before the second and lower ore-shoot was found in the eastern side of the lease. The years 1905 to 1911 marked a return to prosperity. In 1909 the Company purchased a controlling interest in the crushing mill and cyanide plant at Sellheim, on the Burdekin River. From 1911 onwards there has been a yearly decline in the output of stone as well as in value, but the lower shoot paid about £380,000 in dividends.

PRODUCTION.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1889 ..	1,274	382	..	..	..
1890 ..	6,405	4,835	..	..	..
1891 ..	24,002	21,611	..	..	26,250
1892 ..	21,631	21,924	..	..	22,500
1893 ..	45,504	51,471	..	..	97,500
1894 ..	48,240	56,101	..	..	101,250
1895 ..	35,389	37,732	..	..	45,000
1896 ..	9,520	7,480	..	..	..
1897 ..	1,944	1,666	..	..	..
1898 ..	2,253	937	..	..	..
1899 ..	..	..	..	..	..
1900 ..	..	..	..	..	..
1901 ..	286	118	..	..	..
1902 ..	2,183	1,726	..	..	..
1903 ..	3,079	2,042	..	..	..
1904 ..	6,369	4,034	..	..	..
1905 ..	17,927	11,674	..	..	15,000
1906 ..	44,062	35,902	..	..	75,000
1907 ..	49,860	23,536	132,325	215,776	75,000
1908	45,194	25,375	90,172	179,695	75,000
1909 ..	37,502	24,880	75,671	163,060	52,500
1910 ..	25,804	14,180	33,758	83,461	30,000
1911 ..	25,512	11,347	30,679	77,376	30,000
1912 ..	20,384	9,157	25,461	57,571	7,500
1913	9,096	3,729	9,224	22,202	15,000
1914 ..	11,400	8,742	11,080	42,561	..
1915 ..	11,981	9,063	8,853	40,161	..
1916 ..	1,902	1,745	1,478	7,407	7,500

Since 1911 extensive prospecting in the deep ground below 2,200 ft. has been pursued unsuccessfully for further ore. In 1914 the mine was let on tribute and at that time employed about 150

tributers. At the beginning of 1916 the mine was closed down, but a few tributing parties worked throughout the year, hauling their ore through the New Brilliant Freeholds shaft.

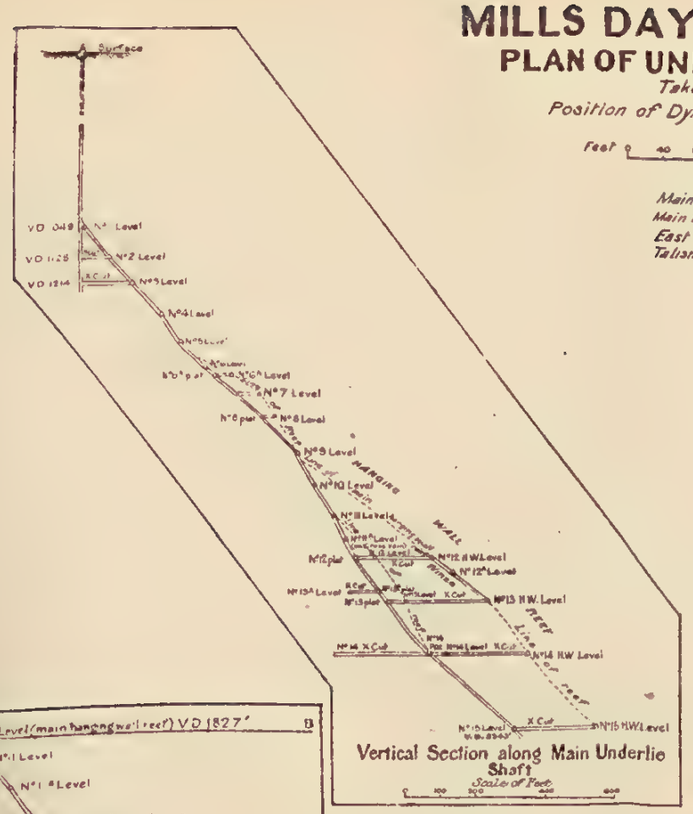
Underground Workings.—The mine was worked from one vertical four-chambered shaft situated close to the southern boundary line. This cut the lode at 1,049 ft., but continues to a depth of over 1,200 ft. and is connected by crosscuts to Nos. 2 and 3 levels. From the No. 1 level (1,049 ft.) the main underlie shaft follows the dip of the lode, angle about 50 degress. Fifteen levels have been driven from this shaft, the lowest being 2,543 ft. in depth. No. 2 level (1,135 ft.) is connected with the School Reserve workings on the east. Nos. 6 and 8 are connected with the Day Dawn Block and Wyndham on the west side. Between Nos. 6 and 9 and Nos. 11 and 14 the shaft lies on the footwall side of the reef and short crosscuts were necessary to work the lode. Near No. 9 the shaft passed through the intersection of the main reef and the hanging-wall reef. No. 12 is connected with Pfeiffer's Mine on the west. At No. 13A and No. 14, crosscuts have been driven into the footwall, respective distances 75 ft. and 275 ft. The underlie continues on the main reef to a depth of 2,550 ft. The hanging-wall workings are connected to the shaft by crosscuts at Nos. 12, 13, 14, and 15 levels. A little stoping has been done on that reef between Nos. 12 and 13. The upper shoot of ore was worked between No. 1A and No. 10 levels on the main reef. Below No. 12 level the main reef was nowhere considered payable. The Talisman workings, in the south-west corner, are connected to the main reef workings at No. 5 and No. 6 levels. This reef dips flatly to the north-west and was extremely rich. The main hanging-wall reef workings, where the lower shoot was worked, lie on the eastern side of the lease and east of a supposed fault. These workings are connected to the main underlie shaft by levels Nos. 6, 7, 8, and 10. The junction of the two reefs forms a moderately wide angle in the vicinity of several diorite-porphyrite dykes. This has always been considered a fault, but the dykes are of earlier age than the lode fissures, and the evidence shows that the main reef fissure passes the dykes but is dying away. Almost all the levels on the hanging-wall reef extend to the New Brilliant Freeholds boundary. A short underlie shaft was used between No. 6 and No. 10 levels. From No. 10, a little to the east, an underlie shaft follows the lode down to the greatest depth attained—about 2,700 ft. Nos. 13, 14, and 15 levels follow the lode westerly as far as the workings near the main shaft, to which they are connected by crosscuts. At No. 16 a crosscut was driven from the underlie shaft 250 ft. into the hanging-wall. Stoping on these workings

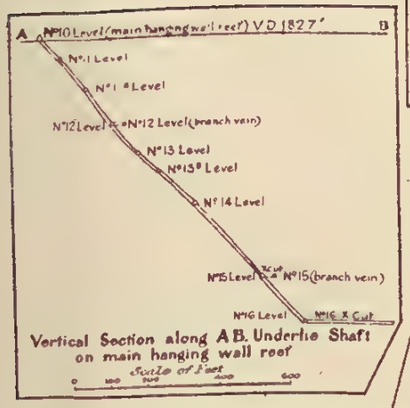
MILLS DAY DAWN UNITED MINE
PLAN OF UNDERGROUND WORKINGS

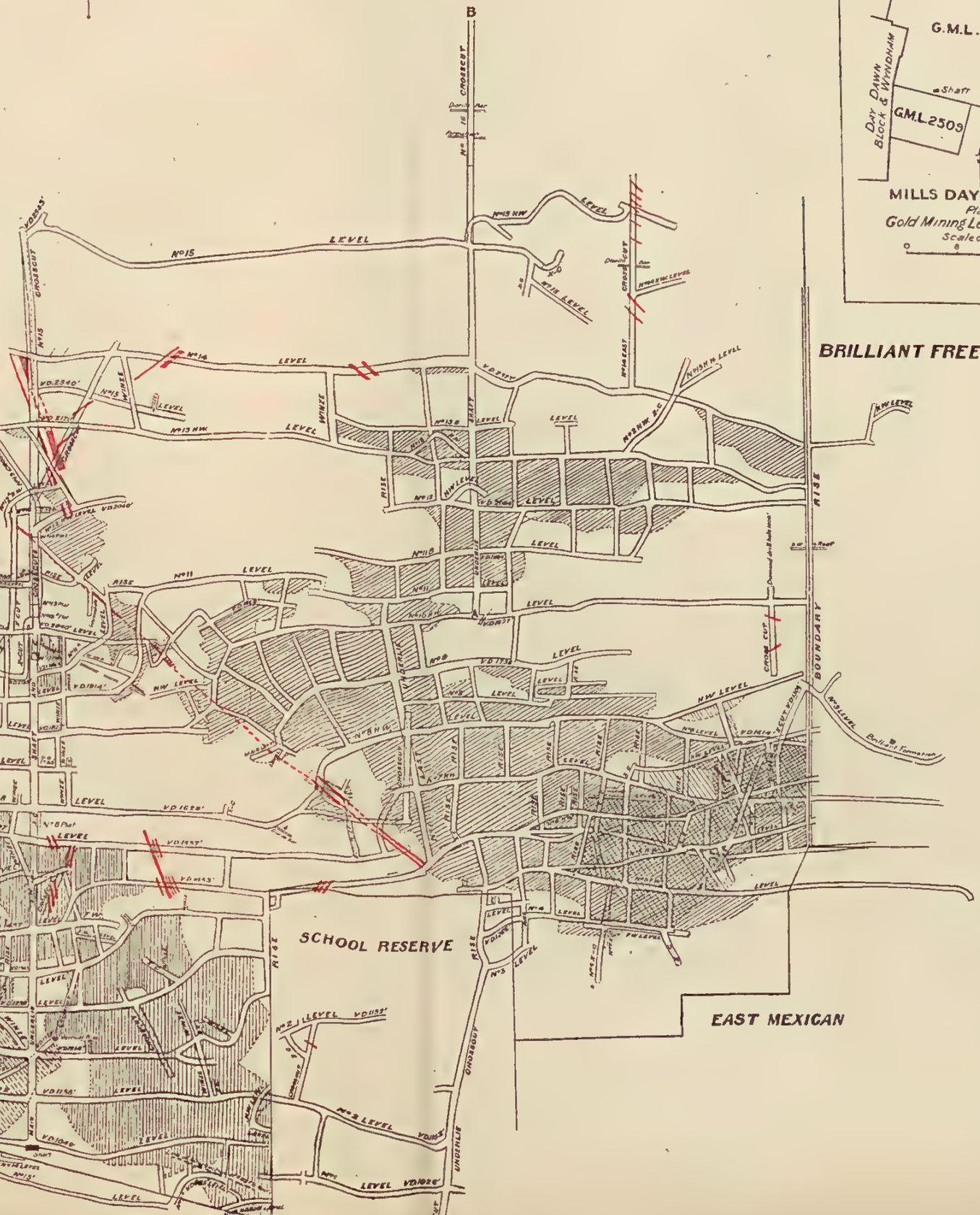
Taken from Mine Managers Plans
Position of Dykes Plotted from Geological Survey (in Red)

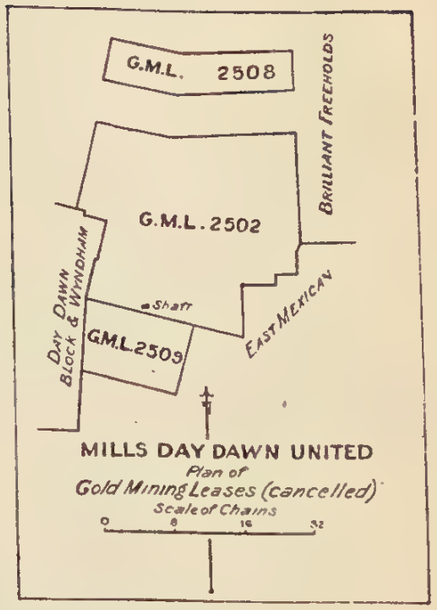
Scale
Feet 0 40 80 160 240 320 420 Feet

Stoping Reference
Main Reef
Main Hanging Wall Reef
East Branch Reef
Talisman Reef




A
B
No 10 Level (main hanging wall reef) VD 1827'
No 11 Level
No 12 Level
No 12 Level (branch vein)
No 13 Level
No 13 A Level
No 14 Level
No 15 Level
No 15 (branch vein)
No 16 Level
No 16 X Cut
Vertical Section along A B. Underlie Shaft on main hanging wall reef
Scale of Feet





BRILLIANT FREEHOLDS

extends between No. 4 (1,266 ft.) and No. 14 (2,322 ft.) levels. The greatest stope length—750 ft.—was worked along No. 8. At No. 6 the lode bulged to 50 ft. thick—the greatest thickness of payable lode found on the field. A small branch on the hanging-wall of this reef junctioned at 350 ft. west of the New Brilliant Freeholds boundary and was stoped out between No. 5 and No. 7 levels. All the ore from these reefs had to be hauled to the underlie shaft on the main reef. A lot of prospecting work has been done on the lower levels since the lower shoot was worked out. Most of this is confined to the hanging-wall reef. Besides the crosscut at No. 16 level another was driven 320 ft. into the hanging-wall from No. 14 near the eastern boundary, and levels have been driven on small veins at Nos. 12, 13, 14, and 15.

Pay Shoots.—Four reefs have been worked in this mine, all of which are associated with the Day Dawn lode. These are the main Day Dawn reef, the main hanging-wall reef, a minor hanging-wall branch reef, and the Talisman. Two large shoots and two subsidiary ones have been worked out. The upper shoot, worked between No. 1A and No. 10 levels on the main reef, is part of an ore-shoot extending from the Day Dawn P.C. Mine in a north-westerly direction through the southern portion of Mills into the Day Dawn Block and Wyndham. It is a continuation of the big shoot worked in the Day Dawn P.C. from the 200-ft. level downwards without a break, although it narrows to a width of about 100 ft. on Mills' boundary. At No. 5 level in Mills United the width of this shoot is 1,050 ft., including the extension into the Block and Wyndham. At the 1,975-ft. level it dies out. The lower shoot, like the upper, is irregular in shape. It is on the main hanging-wall reef. From No. 4 level (1,266 ft.) to No. 10 (1,827 ft.) it pitches north-westerly, but narrowing there it trends to the north-east, striking the boundary at No. 13 (2,170 ft.) level. It terminated at No. 14 (2,322 ft.). The lodes have varied in thickness from a few inches to 50 ft. The average thickness of the quartz worked in the shoots is estimated at 3 to 4 ft. The upper shoot, including the Talisman crushings, averaged 1 oz. of gold per ton, the lower shoot 17½ dwt. per ton.

Geological Features.—The country rock throughout is normal grano-diorite. Dykes of the older and younger series of diorite-porphyrite are abundant in individual groups. At No. 14 H.W. level one dyke is over 20 ft. thick; at No. 6, 1,100 ft. higher, it is represented by a group of six small dykes, indicating the habit of splitting as the surface is approached. The pay shoots do not follow the dyke intersections. The lodes dip north at angles varying from 45 degrees to 55 degrees. A fine-grained

diorite is persistent as a dyke along the hanging-wall lode in the eastern levels. There has been no considerable dislocation of the reefs by faulting. Small movements could not now be easily detected owing to timber, mullock, and diorite masking the walls, but in their general prevalence over the field it is likely that they are numerous.

New Brilliant Freeholds Mine.

Situation, Leases, &c.—The New Brilliant Freeholds Gold Mining Company, Limited, holds two leases, G.M.L. 2390 (32 acres 3 perches) and G.M.L. 2320 (1 rood), lying just within the eastern boundary of the city. Included within the boundaries of G.M.L. 2390 are three freehold allotments under which the Company does not possess the right to mine. The manager is Mr. W. Harris.

History and Production.—As a result of the Brilliant boom in 1890 all the land surrounding the Brilliant P.C. Mine was rapidly taken up, which included the leasehold of this mine. The ground included in the Brilliant Freeholds was originally the eastern ground of Mills United. In 1891 a company was formed, largely of the shareholders of that mine, to acquire the

Plate 27.—New Brilliant Freeholds Mine.

To end of 1916: Ore raised 124,360 tons, value £457,847; dividends, £135,000.

present ground, the intention being to work the Brilliant lode. The vertical shaft was started in 1891 and cut the reef three years later at a depth of 1,160 ft. The lode was opened up by an underlie shaft and the first crushing was recorded in 1894, 200 tons of ore yielding only 26 oz. of gold. Up to 1897 the underlie

NEW BRILLIANT FREEHOLDS

Including Redmonds Brilliant Freeholds and Day Dawn

PLAN OF WORKINGS

On Day Dawn Lode

Scale

Feet 0 40 80 160 240 Feet

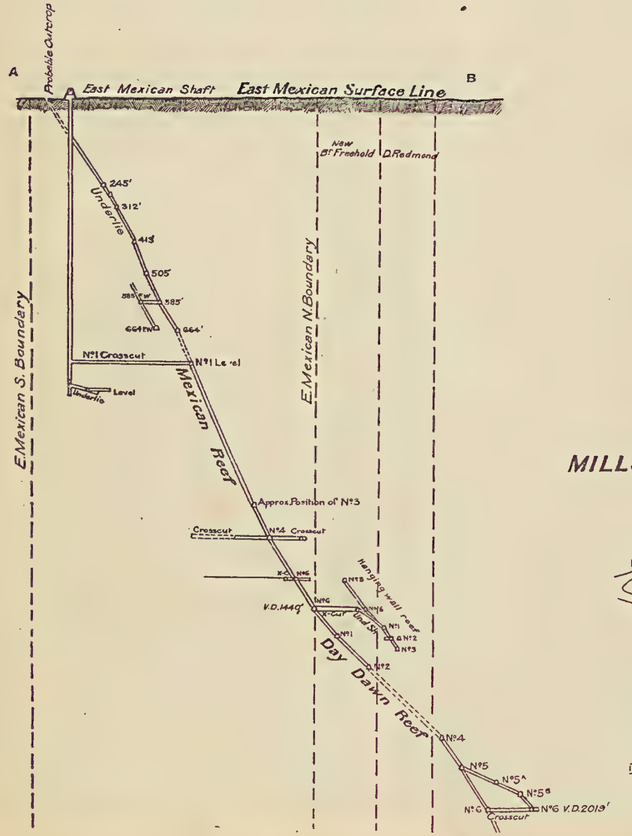
Reference

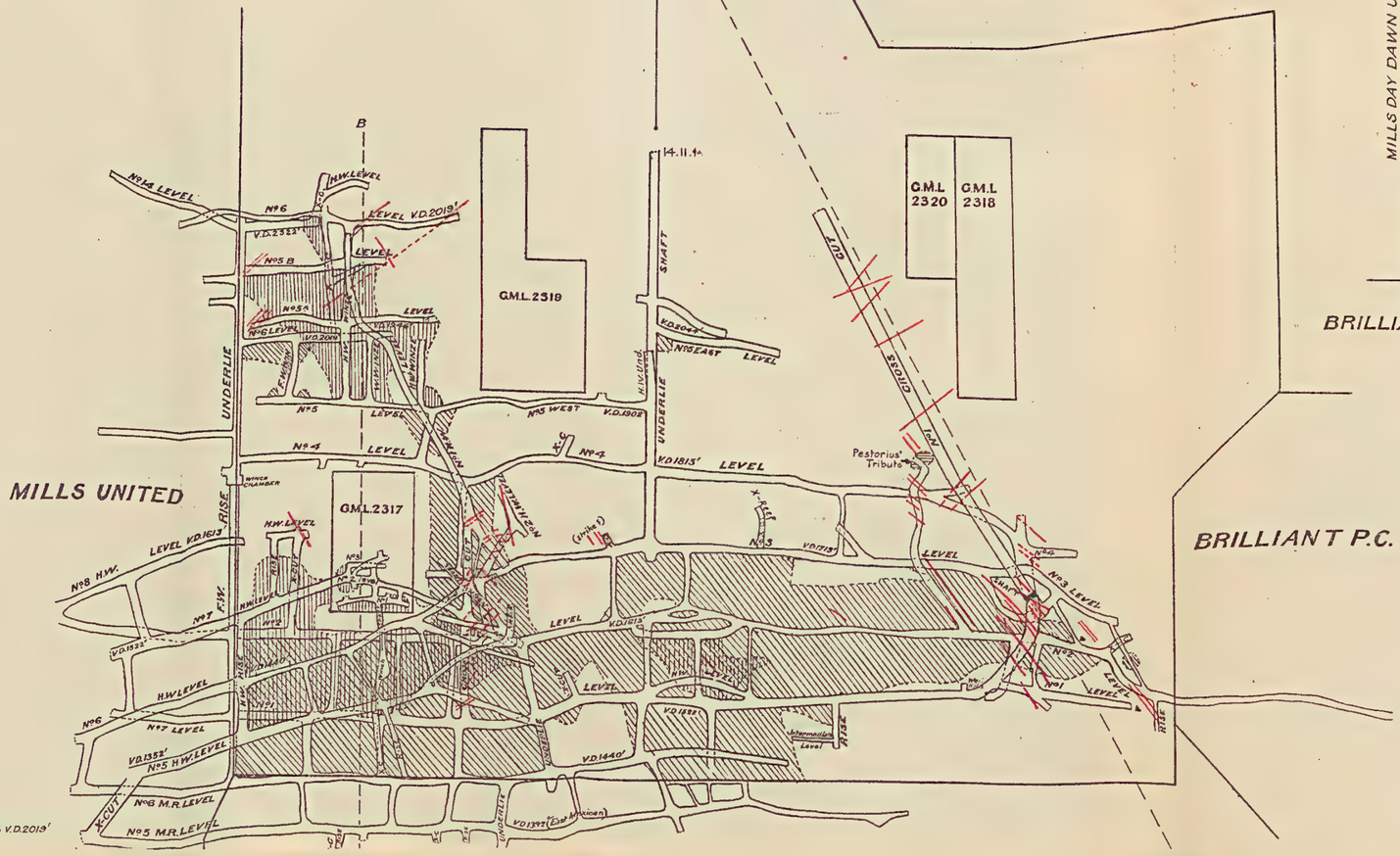
Day Dawn Main Reef

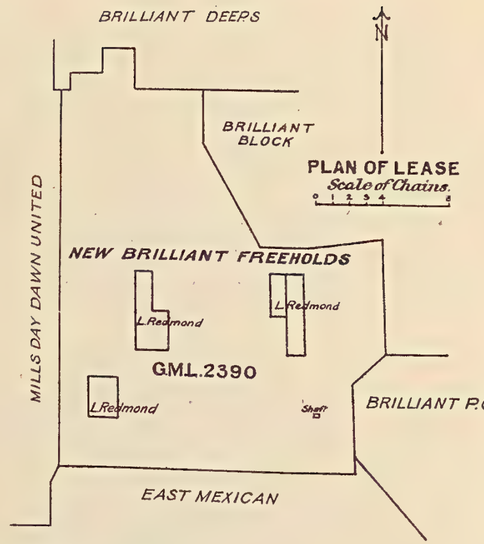
Day Dawn Hangingwall Reefs

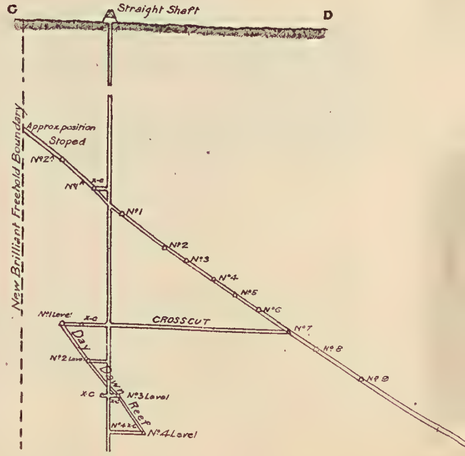
Cross Reef (Day Dawn Formation)

Dykes in Red









had been sunk to a depth of 1,400 ft. on a small and poor reef. the best block of ore being located in the corner adjoining the Brilliant P.C. lease. The Brilliant reef was worked until 1903, when the Company was reconstructed as the New Brilliant Freeholds. In 1907 the Day Dawn lode underneath was worked from Mills United Mine and regular crushings and dividends were the order from 1908 onwards. The straight shaft was eventually sunk and cut the Day Dawn lode at a depth of 1,680 ft. In the last five years the Day Dawn reef has been opened up to a depth of over 2,300 ft. During 1914 and 1915 the underlie shaft on the Brilliant reef was sunk further to a depth of 1,800 ft. without revealing any payable ore.

PRODUCTION.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1894 ..	200	26	..	..	..
1895 ..	860	804	..	..	..
1896 ..	1,800	1,172	..	..	..
1897 ..	3,551	2,571	..	..	..
1898 ..	1,031	548	..	..	..
1899 ..	2,204	1,766	..	..	..
1900 ..	..	..	..	..	..
1901 ..	1,647	1,631	..	..	..
1902 ..	1,426	1,042	..	..	..
1903 ..	1,665	1,068	..	..	..
1908 ..	3,473	3,134	6,440	17,424	..
1909 ..	9,828	8,744	18,510	49,307	7,500
1910 ..	28,992	24,101	41,024	126,201	45,000
1911 ..	20,123	15,896	25,553	81,993	45,000
1912 ..	18,640	10,551	15,371	52,569	26,250
1913 ..	10,135	5,565	7,710	27,189	3,750
1914 ..	8,752	4,946	5,939	23,281	..
1915 ..	6,774	5,569	4,797	24,139	3,750
1916 ..	3,249	3,403	6,634	18,547	3,750

There were no returns for years 1904-7.

Underground Workings.—Brilliant lode: A four-chambered vertical shaft cut the lode at 1,160 ft., a little above No. 1 level. An underlie shaft has been sunk on the lode to a depth of 1,800 ft. No. 1 level extends into the Brilliant P.C. on the east and to the East Mexican boundary on the west. No. 2 is a short level. No. 3 W. has followed a vein almost to Mills United boundary. All the lower levels are short, No. 7 west, driven 260 ft., being of greatest length. At No. 5 west a crosscut was driven 160 ft. into the footwall. Behind the shaft a rise was put up and connected to No. 7 level Brilliant P.C. Mine. A small block of ore was stoped between No. 3A and No. 1A levels. A little stoping

has also been done on the west of the underlie shaft between No. 2 and No. 7. Operations on these workings were unprofitable. No. 10 level (1,793 ft.), the lowest on this lode, has recently been driven 70 ft. to the east on a vein a few inches thick. No. 10 west has been driven 120 ft. There is no profitable ore in sight for the Company on these workings, but tributers have been profitably employed in the upper west levels. From No. 7 plat a crosscut connects with the Day Dawn workings at No. 1 level and the vertical shaft.

Day Dawn lode.—The vertical shaft cuts this lode between No. 2 and No. 3 levels at a depth of about 1,680 ft. No. 1 and No. 2 west extend to Mills United boundary, being a continuation of Nos. 7 and 8 levels in that mine. No. 3 extends to Redmond's Freehold (G.M.L. 2317). Between No. 1 and No. 3 most of the payable ore from the mine has been obtained, and between the shaft and Mills United boundary it is almost completely stoped out. No. 4 west extends to the boundary of lease. All these levels are connected with the vertical shaft by short crosscuts. The depth of the vertical shaft is 1,865 ft. Below No. 4 level (1,815 ft.) the lode is worked by two underlie shafts, one on the west boundary and one in the centre of the lease. At No. 5 the reef splits and a small shoot was worked on the hanging-wall branch (dip 27 degrees) on the west boundary down to No. 6 (depth 2,019 ft.). The main reef was also followed to the same depth and connected to the other by crosscut. At a depth of 2,322 ft. No. 14 level in Mills United Mine, which had followed the shoot of ore to the eastern boundary, was driven 90 ft. east into the Freeholds Mine. This was connected to No. 6 by a rise along the boundary, but no payable ore was revealed either in the level or rise. In the centre underlie shaft the lode was followed for 270 ft. without payable ore. The hanging-wall reef in Mills United was followed into the mine and stoped to a point 300 ft. east of the boundary between No. 5 and No. 7 (Mills United levels). A north crosscut from No. 1 at this point intersected a reef striking N.N.W., and dipping towards the east, at 230 ft. from the level. This was followed to the north for over 400 ft. and opened at No. 2, but yielded no payable ore. On the east of the shaft No. 2 level was driven into the Brilliant P.C. and it ultimately connects with a crosscut from the vertical shaft of that mine.

Ore Shoots.—On the Brilliant a small vertically-pitching shoot averaging a width of 80 ft. was worked between No. 2 and No. 7 levels on the west side of the underlie shaft. Length of shoot 450 ft. It averaged about 16 dwt. per ton. The big shoot on the Day Dawn, from which £130,000 in dividends have been

NEW BRILLIANT FREEHOLDS

Including Redmonds Brilliant Freeholds and Day Dawn

PLAN OF WORKINGS

On Brilliant Lode

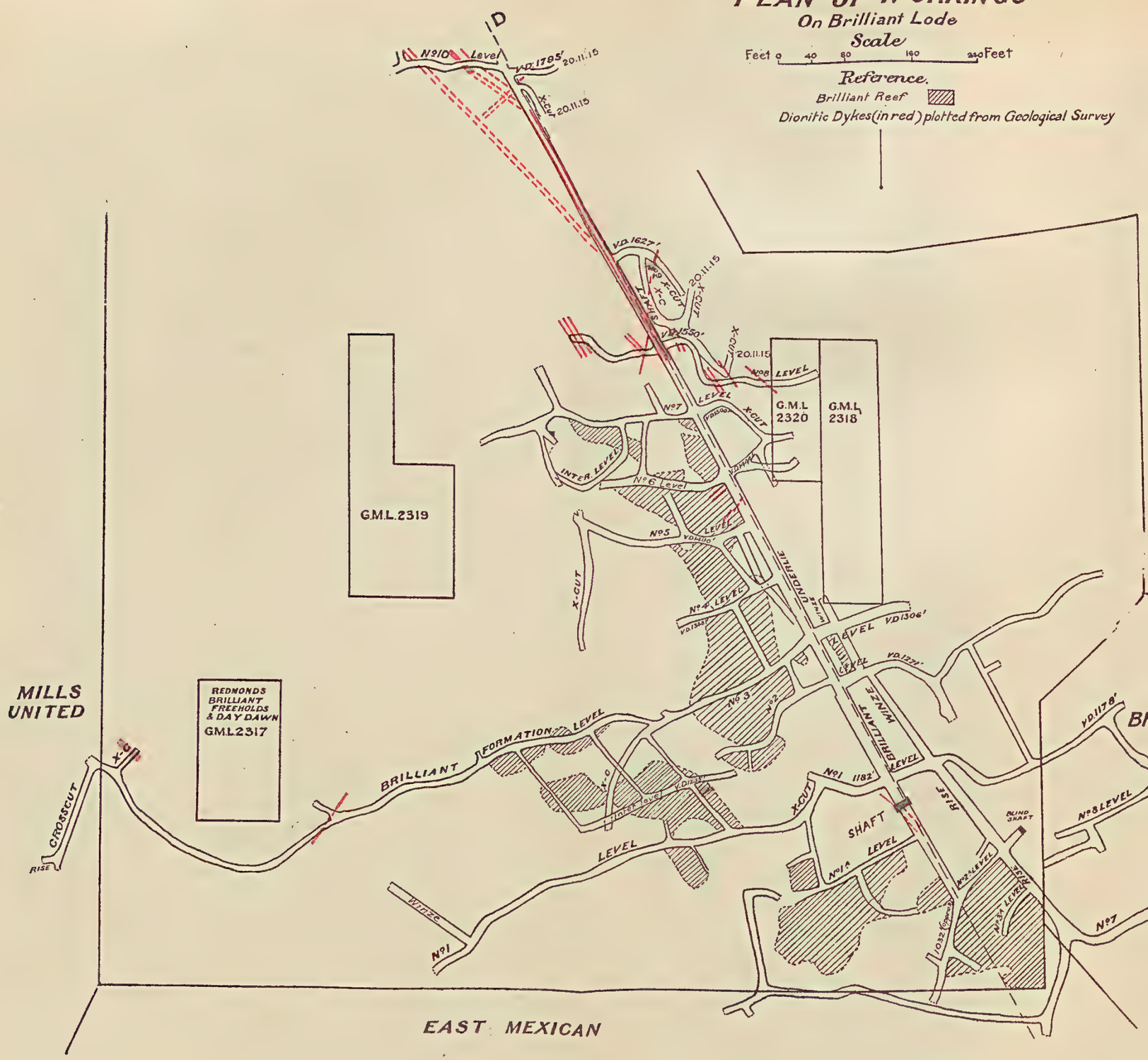
Scale

Feet 0 40 80 160 240 Feet

Reference.

Brilliant Reef

Dioritic Dykes (in red) plotted from Geological Survey



BRILLIANT BLOCK

BRILLIANT DEEPS

BRILLIANT BLOCK

MILLS DAY DAWN UNITED

NEW BRILLIANT FREEHOLDS

L. Redmond

L. Redmond

G.M.L.2390

L. Redmond

Shaft

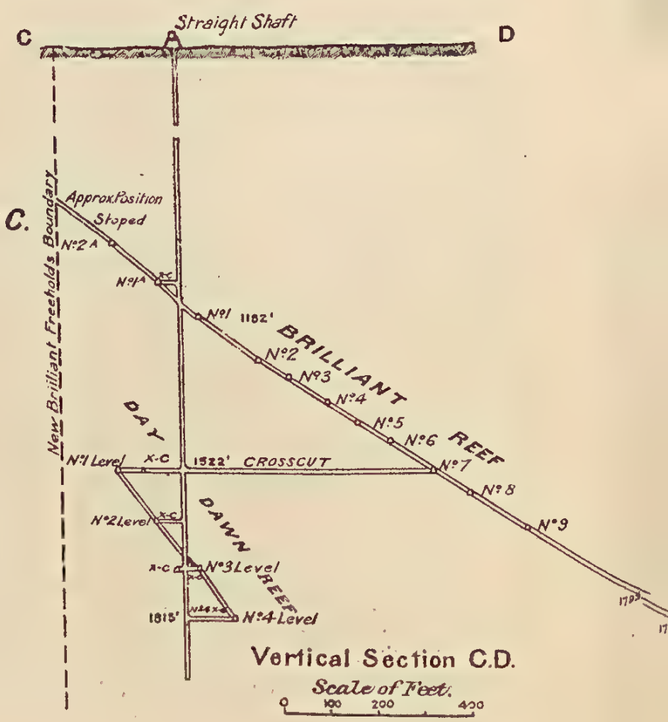
BRILLIANTAN

EAST MEXICAN

Plan of Lease

Scale of Chains

0 1 2 3 4 5



Vertical Section C.D.

Scale of Feet.

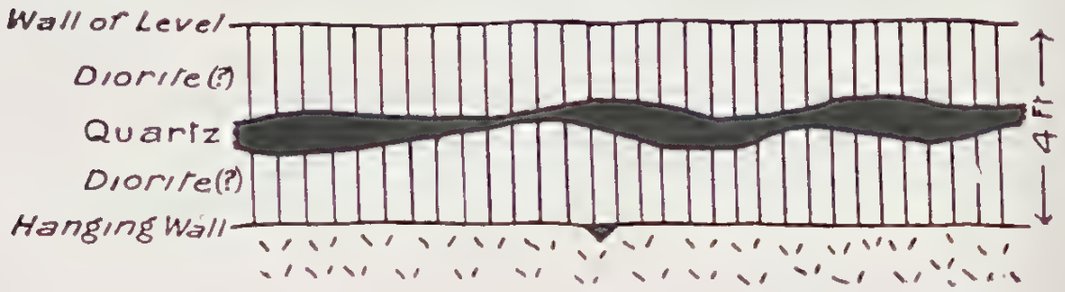
0 100 200 400

paid, is an easterly and lateral extension of the lower shoot in Mills United. Along Nos. 1, 2, and 3 it has been stoped for 1,000 ft. and on the dip of the lode for 400 ft., the upper portion overlapping into the East Mexican Mine. On the west side of the lease a section of the shoot trends north-westerly and passes into a hanging-wall branch reef, where it terminated at a depth of 2,000 ft. Stoping by the Company is now only proceeding on a shoot on the hanging-wall reef which passes into the East Mexican above the southern boundary.

Geological Features.—The country rock is grano-diorite. The eastern ground near the vertical shaft is a maze of diorite-porphyrite dykes both of the older and newer series. The earlier series continuing pass through the western workings. In this mine the western extension of the Brilliant overlaps the Day Dawn lode, the difference in depth at the shaft being 520 ft. From the data available in this mine, the Brilliant and the Day Dawn, if they come in contact, should junction in the extreme western portion of the Victory lease (No. 1744) at a depth of approximately 500 ft, the line of theoretical contact descending in a north-westerly direction through the East Mexican into Mills United. The Brilliant, however, has been practically worthless west of the Brilliant P.C. Mine, and crosscuts in search of it in Mills United have not revealed any defined lode which may be correlated with it. The Brilliant lode dips a little west of north at an average angle of 32 degrees. The fissure represents a normal fault of slight movement, evidenced by the dislocation of the igneous dykes. The fissure is narrow and the reef in this mine seldom attained 18 in. in width. The Day Dawn lode dips to the north at an angle of 50 degrees. Down to No. 4 the lode has followed a dioritic dyke up to 20 ft. in thickness. This dyke extends into Mills United on the west and the Brilliant P.C. on the east. At No. 6 it was not seen. This dyke is characteristically broken and very rotten on exposed walls and is replaced by the quartz of the reefs usually on a wall but sometimes in the middle of the dyke.

The diorite (?) sometimes alters to a grey colour, accompanied with formation of secondary pyrite, the appearance of which is said to indicate gold. Three branches of the Day Dawn lode have been worked in this mine. The reef minerals are the usual sulphides, but a telluride of gold was found while working a small patch of specimen quartz in the hanging-wall reef near Redmond's lease between Nos. 1 and 2 levels. It appears to be isolated at this spot.

Faulting.—Seventy feet to the east of the vertical shaft a fault has thrown both reefs back about 30 ft. on the east side. The strike of the fault is north-west to south-east and the angle of inclination is to the south-west but nearly vertical. No enrichment of either of the lodes has occurred along this fault. It has



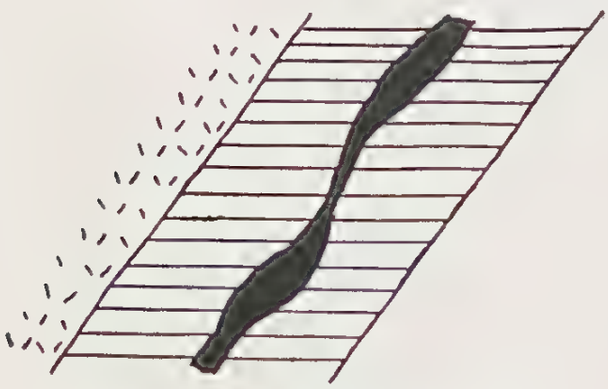


FIG. 9.—QUARTZ VEIN IN DIORITE (?).
No. 1 East Level, New Brilliant Freeholds Mine. (Sketch Plan and Section.)

been the opinion on the field that the Day Dawn lode is faulted by a large (diorite) dyke east of the shaft. It has already been proved that the lodes are later than both series of diorite-porphyrite dykes, the evidence of which may be particularly well noticed in No. 8 east and west levels on the Brilliant reef. The so-called "big" dyke recently intersected in the No. 10 (Brilliant) west level proves to be only 4 ft. thick and is one of a series of dykes which cross the underlie shaft at an acute angle. A companion dyke is clearly faulted by the reef fissure 15 ft. west from the shaft in No. 10 level, but at the "big" dyke the fissure has gone underfoot in the level and the intersection with the dyke is therefore not visible. On the supposition that the reef is faulted by this dyke the Company was crosscutting to the north to pick up the reef on the northern side of the dyke, a futile operation in view of the evidence. The reef fissure, which is small and carries a vein of poor quartz, by passing underfoot about 40 ft.

from the shaft should be picked up on the south side of the level, but it gives little prospect of proving payable when the character of the fissure and the depth are considered.

Recent Developments.—On the Day Dawn lode development work has recently been at a standstill (A.D. 1916) and operations have been confined to stoping the small ore reserves on the hangwall reef. The rise from No. 5 level to the boundary exposed an average of 18 in. of medium grade ore for a distance of 155 ft. on the dip of reef. On the west side the reef has been worked out as far as payable.

On the Brilliant lode development work has been the sinking of the underlie shaft to No. 10 level (v.d. 1,795 ft.) which has been driven 200 ft. No payable ore was found nor does there appear to be much probability of adding to the ore reserves by further work here in the absence of a well defined lode fissure. The work has only opened up several small impoverished fissures which it is impossible to correlate definitely with the Brilliant lode. One of these in No. 10 west level carries bunches of quartz with a little pyrite to 1 ft. thick, but does not average 6 in. for a distance of 40 ft. Up to the end of 1914 the main Day Dawn lode had been opened up to a depth of 2,300 ft. by a shaft from No. 3 level and by the No. 14 (Mills' United) level on the west boundary, so that further development work at greater depth is not likely to be attempted. In brief, development work appears to have exhausted every reasonable probability of adding to the ore reserves. The mine is now being worked by tributers.

East Mexican Mine.

Situation, Leases, &c.—The mine is situated on G.M.L. 2251 held by the East Mexican Gold Mining Company, Limited. The lease is south of and adjoins the New Brilliant Freeholds Mine and it lies between Mills' United on the west and the Brilliant P.C. on the east. The manager is Mr. W. A. Lewis.

History and Production.—The present lease includes the land held separately at one time as the Mexican P.C. and the East Mexican. Operations date from the early days of the field, and after many vicissitudes the Mexican P.C. area is again being worked at the present time. The Mexican reef, said to be named after John White ("Mexican Jack"), who was one of the first shareholders, outcropped within the lease, and operations were first carried out with success on it just behind the present shaft. Messrs. W. J. Paull and party purchased the lease in 1882 and worked the reef to a depth of 650 ft. Over 5,000 oz. of gold were obtained from these workings, and the shoot dying out the

vertical shaft was sunk to a depth of 850 ft. in the hope of cutting the main Day Dawn lode, without meeting anything payable. Operations were continued until 1897 and the mine was closed down under exemption. In 1899 it was transferred to the East Mexican Company and amalgamated with G.M.L. 1277, the adjoining lease on the east held by that Company. The shaft and workings known as the Great Eastern are situated on the east boundary of G.M.L. 1277. This ground had been worked unsuccessfully since 1885 both for the Mexican and Brilliant reefs. There were no returns, however, until 1897, the ore then being obtained from the Mexican reef. The ore shoot worked in the Brilliant P.C. cut out on the boundary. From 1899 to 1905 the two leases were worked together without much success. In 1906 the Company was reconstructed, the new lease (G.M.L. 2251) taking in the two old leases, and operations commenced on the Mexican reef below the old workings. Crushings from there have been regular from 1908 to 1914 when the ore reserves on that reef became exhausted. In 1915 work was started on the Day Dawn hanging-wall reef which was being worked in the New Brilliant Freeholds.

PRODUCTION.

From 1875 to the end of 1881 the Mexican P.C. Mine returned 3,232 oz. of gold from 2,725 tons of ore treated. There were no returns from 1882 to 1884. From 1885 to 1899 the same mine (G.L. 947, Mexican G.M. Co.) returned 5,497 oz. of gold from 2,941 tons of ore. The original East Mexican mine (G.L. 1277) returns from 1897 to 1904 were 3,563 tons of ore, yielding 3,538 oz. of gold. There were no returns from 1905 to 1907, the later returns of the present Company being given in the table below.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value.	Dividends.
	Tons.	Crude oz.	£	£	£
1908 ..	92	72	773	1,029	..
1909 ..	112	44	230	391	..
1910 ..	1,569	1,395	8,526	13,384	..
1911 ..	12,493	8,437	27,305	56,610	33,972
1912 ..	4,877	2,072	5,589	12,771	..
1913 ..	1,538	922	1,225	4,186	..
1914 ..	296	342	244	1,478	..
1915 ..	777	1,086	2,802	6,564	3,087
1916 ..	2,593	2,146	3,488	10,998	..

Underground Workings.—The present working shaft, which is in the western half of the lease, has been sunk vertically 850 ft. At 88 ft. is the No. 1 level of the old workings. From

EAST MEXICAN MINE.

Plan of Workings.

Reference.

Stoping Main Reef
Stoping Hangmg Wall Reef
Stoping Footwall Reef

Taken from plans supplied by inspector of Mines & Messrs E D Miles & Co

Scale of Feet

0 80 160 240 320

NEW BRILLIANT FREEHOLDS

MILLS DAY DAWN UNITED

DAY DAWN P.C.

BRILLIANT P.C.

Brilliant formation

Freeholds

(East Mexican)

Mexican Crosscut

Underlie

Crosscut

Rise

X-Cut

Level

Shaft

Old Shaft

Bore Hole

Engine Room

Section Line A B

No7 Level
No7 H.W. Level
No6 H.W. Level
No6 Level
No5 H.W. Level
No5 Level
No4 Level
No3 Level
No3 H.W. Level
No3 inter. Level
No2 Level
No1 Level
No1 H.W. Level
H.W. Level
Mexican Level V.D. 1065'
Engine Room Level V.D. 660'
Level V.D. 505'
Level V.D. 312'
Level V.D. 243'
Level V.D. 180'
Level V.D. 863'

V.D. 1456'
V.D. 1374'
V.D. 1360'
V.D. 1272'
V.D. 1222'
V.D. 1188'
V.D. 1146'
V.D. 1024'
V.D. 1053'
V.D. 1476'
V.D. 1390'
V.D. 1003'
V.D. 760'
V.D. 588'
V.D. 413'
V.D. 1324'

24.12.15
24.12.15
176°
244
300'
210°

Vein 1
Vein 2

East Mexican G.M.L.2251

Shaft
A
B
68 Level
162'
245'
320'
415'
605'
585'
664'
Mexican Footwall Reef
Projection of Dip of Reef 10 D.P.C.
X-Cut
VII Level (Lower Workings)
Reef
Datum
Sea Level
N°3 H.W. Level
N°4 H.W. Level
Macfarlane's X-Cut
Bore Hole
N°6
N°5
Reserve

Section along Line A B (see plan of Workings) Plotted from Plans of Workings

Feet 264 132 0 2 4 6 8 Chains
Scale

this an underlie shaft goes down to a vertical depth of 664 ft. at an angle of about 60°. The depths of the intermediate levels off this shaft are 165, 245, 312, 415, 505 and 585 ft. The five upper levels are short. The length of the *505-ft. level* is 260 ft. east, 380 ft. west; the *585-ft. level,* east 320 ft,, west 200 ft.; the *664-ft. level,* east 320 ft., west 65 ft. On both sides of the shaft for a distance of 80 ft. the reef has been stoped between the 88 and 245 ft. levels. Below the latter level all of the stoping has been done to the east of the shaft; in the two lowest levels the payable ore gave out 300 ft. east of the shaft. At 760 ft. in the vertical shaft, a northerly crosscut connects with the lower workings on this reef. The continuity of this reef has been proved by a rise put up from the No. 1 level (lower workings), which broke through into the 664-ft. level. The crosscut at 760 ft. cut the Mexican reef at a distance of 410 ft. and the reef was followed along this level (No. 1) for 360 ft. to the west and 980 ft. to the east. At 320 ft. east of the crosscut an underlie shaft was sunk on the reef to the boundary of the New Brilliant Freeholds. The stoped areas lie between Nos. 4 and 6 levels. Above the former the lode was unpayable on the lower workings. Several crosscuts and boreholes have been put in from these workings into the footwall of the lode in the hope of getting a continuation of a payable reef on the main Day Dawn fissure. At a depth of 820 ft. in the vertical shaft a flat vein of quartz dipping north-west was cut. An underlie was sunk 80 ft. and a level driven for 500 ft. at a depth of 830 ft. without any encouragement, when work was stopped.

The present workings are on the Day Dawn hanging-wall reef, which has now been practically worked out in the New Brilliant Freeholds. A crosscut from No. 4 level (v.d. 1,272 ft.) cut this reef at 100 ft. to the north, and it has been driven on for a distance of 360 ft., and stoped at intervals for about 160 ft. No. 3 crosscut was driven from a point 30 ft. west of the underlie shaft. The hanging-wall country above No. 3 level has been neglected as far as crosscutting is concerned, and there is a prospect that the reef now being worked may extend upwards to the surface east of the vertical shaft. No. 1 crosscut, west of this shaft, is 115 ft. long, but has not been driven sufficiently far to prove the absence of a reef there.

On the east boundary of the present lease an old vertical shaft known as the Great Eastern was sunk to a depth of 1,324 ft. Nothing payable was intersected. At 403 ft. an underlie shaft was sunk to a depth of 950 ft. and a crosscut driven north 80 ft. from the bottom, which intersected a vein of the Brilliant

lode. Nos. 6 and 7 levels in the Brilliant P.C. have been extended over 500 ft. into this lease in the north-east corner, but nothing payable was ever located. The pay shoot in the Brilliant P.C. terminated right at the boundary.

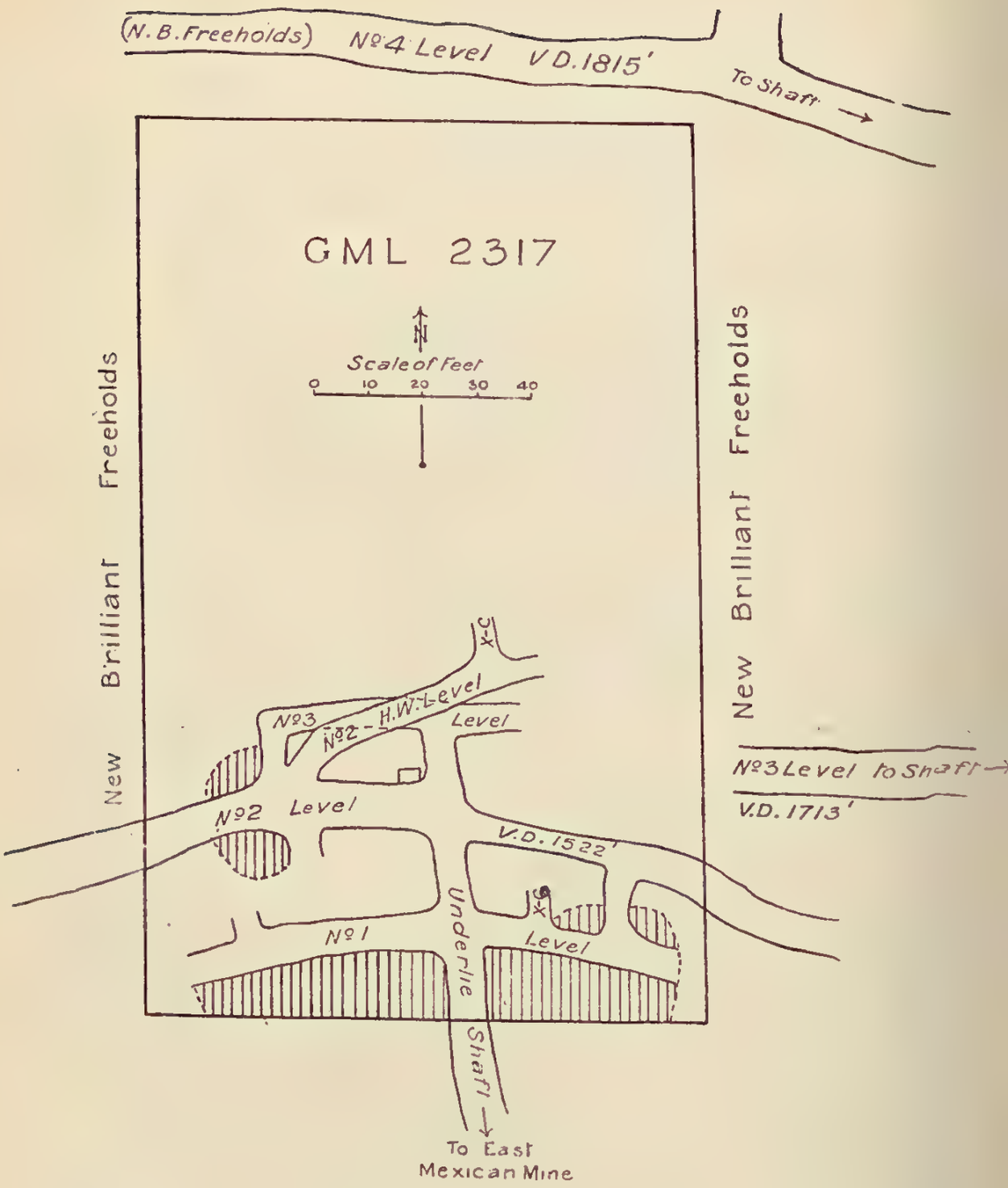
Geological Features.—The geological formation is similar to that of the New Brilliant Freeholds Mine, the diorite porphyrite dykes in which are again picked up in this mine.

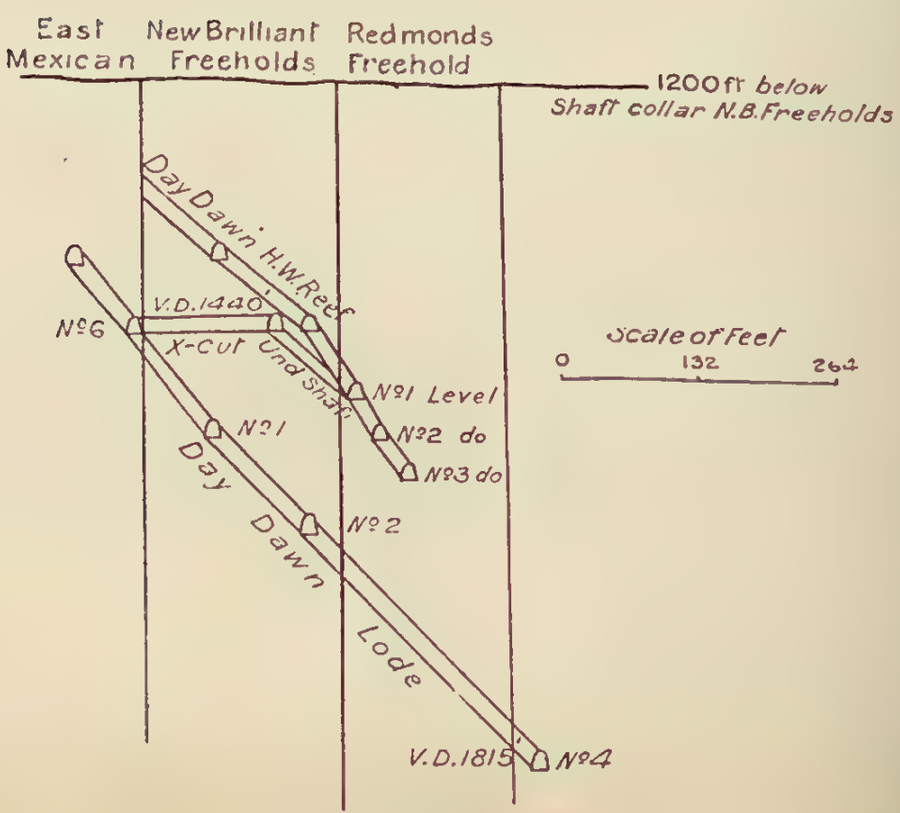
Ore-shoots.—A shoot was worked from the surface on the Mexican reef for a distance of 800 ft. on the lode. The width never exceeded 200 ft. and the shoot from the surface pitched to the north-east. The crushings from the lower portion of this shoot averaged 1·5 oz. of gold per ton.

In the lower workings (Mexican reef) only the upper fringe of the large shoot worked deeper on the same lode in the New Brilliant Freeholds and Mills United extended into this mine. It averaged just over 1 oz. of gold per ton. The shoot at present worked is on the hanging-wall reef and is a continuation of that worked in the New Brilliant Freeholds.

Development Work.—While stoping is proceeding upwards from No. 4 level, crosscuts from the old workings should gradually be increased to prove the upward continuation of the reef. Beyond the No. 1 crosscut (v.d. 760 ft.), which was driven 115 ft., the hanging-wall country has scarcely been tapped, and there is thus a possibility of some persistency in the reef now being worked. At No. 4 level the reef is, however, only payable for less than half the distance driven on. The stopes show a maximum thickness of 18 in. of well-mineralised ore, but the way the good ore cuts out and is replaced entirely by "formation" is disconcerting. There are a good number of such blanks among the stopes, which start at a rise 60 ft. east of the crosscut and continue almost to the Brilliant Freehold boundary. The mine does not promise to materially assist in relieving the shrinkage in the output of the field, but as it is being worked upward the ore should as usual improve, and there is, at time of writing (1916), a possibility of prospecting work (by crosscutting) proving a payable reef above No. 3 level.

South of the Mexican reef the country was some years ago prospected for a continuation of the main Day Dawn reef worked in Mills United. Two footwall crosscuts and a borehole up to 300 ft. long, between 800 and 1,400 ft. deep, in addition to the vertical shaft, did not locate it. In the eastern ground of Mills United it decreased in size and appeared likely to cut out, while the main hanging-wall reef replaced it, and it is this


(N.B. Freeholds) №4 Level V.D. 1815'
To Shaft
GML 2317
N
Scale of Feet
0 10 20 30 40
New Brilliant Freeholds
New Brilliant Freeholds
X-C
№3
№2 - H.W. Level
Level
№3 Level to Shaft
V.D. 1713'
№2 Level
V.D. 1522'
X-C
№1
Underlie
Level
Shaft
To East Mexican Mine

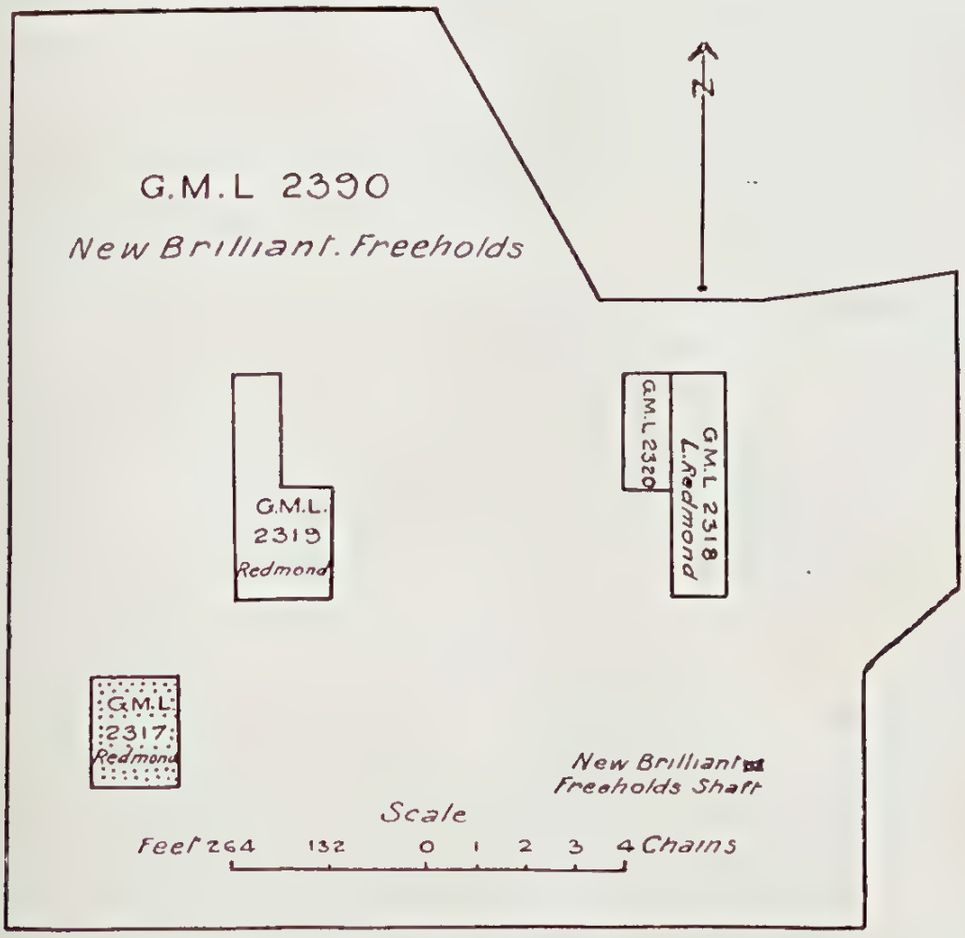

East Mexican
New Brilliant Freeholds
Redmonds Freehold
1200 ft below Shaft collar N.B. Freeholds
Day Dawn H.W. Reef
V.D. 1440'
№6
X-Cut
Und Shaft
№1 Level
№2 do
№3 do
№1
Day Dawn Lode
№2
V.D. 1815'
№4
Scale of Feet
0 132 264

reef that has been followed to the east through the New Brilliant Freeholds into the Brilliant P.C. Mine. This is continuous with the Mexican reef, which is thus a hanging-wall reef on the Day Dawn lode system.

As this reef has not been faulted to any extent the only conclusion that can be drawn is that the fissure carrying the big Day Dawn footwall reef further west has died out in the intervening country.

Redmond's Brilliant Freeholds and Day Dawn.

Situation, Leases, &c.—Included within the boundaries of G.M.L. 2390, the New Brilliant Freeholds lease, are three freehold allotments owned by L. Redmond. These are covered by G.M.L. 2317 (1 rood 23½ perches), G.M.L. 2318 (1 rood 36¾ perches), and G.M.L. 2319 (2 roods 27½ perches). A private



Plan 7.—Redmond's Brilliant Freeholds and Day Dawn Leases.

company was formed in 1913 to work these leases, but operations have been confined to G.M.L. 2317 situated in the western portion of the New Brilliant Freeholds lease.

Description of Mine.—Mining operations have in the past been carried on from the East Mexican shaft but it was lately worked from the New Brilliant Freeholds shaft. From the

No. 6 west (East Mexican) level (v.d. 1,440 ft.), a crosscut was driven north into the New Brilliant Freeholds ground a distance of 120 ft. From the end of this an underlie shaft was sunk cutting the Day Dawn hanging-wall reef at a depth of 1,490 ft. At this point No. 1 level was opened and driven 50 ft. west and 40 ft. east. The reef above this level has been stoped out to the south boundary. A small block was stoped out below No. 1 east. The underlie was sunk a further 90 ft. on the reef, but at that point the sink only showed 12 in. of unpayable quartz. No. 2 level (1,522 ft.) has been driven to both boundaries, total length 110 ft., and connected to No. 1 H.W. level in the Freeholds Mine. No. 2 west cut payable quartz 15 ft. from the shaft, which continued to within 10 ft. of the boundary. No. 3 level (v.d. 1,558 ft.) was driven 30 ft. west and 15 ft. east on an unpayable reef. At No. 2 west, about 25 ft. from the shaft, a level was driven 50 ft. on a vein going into the hanging-wall. The mine was worked from September, 1913, to the middle of 1916. Both hanging and footwall Day Dawn reefs were worked. On the former, where the company had ceased work at No. 3 level, tributers opened up a reef carrying up to 3 ft. of payable quartz below that level.

As regards G.M.L. 2318 and 2319 there is no likelihood of these ever being worked as the New Brilliant Freeholds have proved the Day Dawn and Brilliant lodes unpayable in proximity to their boundaries.

The mine was worked from September, 1913, to the year 1916, when it was closed down. It was seriously handicapped by having no shaft on the lease, and the working conditions contributed to high mining costs.

PRODUCTION.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value.	Dividends.
	Tons.	Crude oz.	£	£	£
1913 ..	235	338	425	1,820	539
1914 ..	1,998	2,168	2,472	10,244	1,178
1915 ..	358	319	821	1,970	..
1916 ..	585	513	422	2,243	..

DAY DAWN P.C. MINE.

This lease included the original prospecting claim on the Day Dawn lode. The history of the mine well illustrates the uncertainties of mining, for during a period of four years the ground was repeatedly taken up, worked, and then abandoned, yet it is reported to be the first lode mine in Queensland to

yield £1,000,000 worth of gold. It was the pioneer of the important mines of the field and was worked as early as 1874 by F. Pfeiffer and party. The first crushing recorded was obtained in March, 1875, 37 tons of quartz returning 42 oz. of gold. The reef, however, was patchy. It was not until 1878 that success was attained, and then the second largest ore-shoot of the field was discovered at a depth of about 200 ft., and from 1879 onwards large dividends were paid to the shareholders. At this time, Messrs. F. Pfeiffer, T. Christian, and G. M. Ievers were associated with the mine and held a controlling interest. The mine ranks as the fifth largest producer on the field, the total returns being 275,128 tons of ore raised for 379,859 oz. gold and residues valued at £8,854. From 1879 to 1901 the dividends paid amounted to £638,000. From 1902 onwards the returns grew less and it was latterly worked by tributers. In 1913 the mine was finally closed down.

While patches of payable ore were found near the surface the lode was not payable until a depth of nearly 200 ft. was attained. From there the ore-shoot continued persistently to the boundary of Mills United at a depth of 1,040 ft. and extended 600 ft. east of the underlie shaft, which ran down close to the western boundary of the lease.

Production.

Year.	Ore Raised.	Gold.	Year.	Ore Raised.	Gold.
	Tons.	Crude oz.		Tons.	Crude oz.
1881 ..	5,678	13,933	1890 ..	28,970	26,814
1882 ..	11,226	22,778	1891 ..	27,416	27,479
1883 ..	8,021	18,077	1892 ..	14,651	14,430
1884 ..	11,331	30,130	1893 ..	6,459	8,832
1885 ..	18,510	34,775	1894 ..	3,515	6,886
1886 ..	18,558	29,365	1895 ..	3,958	5,445
1887 ..	19,746	25,475	1896 ..	2,370	2,445
1888 ..	22,349	24,919	1897 ..	9,630	16,913
1889 ..	27,035	31,816	1898 ..	4,692	6,468

From 1899 to 1913 inclusive, 29,844 tons of ore were raised, yielding 31,904 oz. gold and residues valued at £88,541.

Day Dawn Block and Wyndham Mine.

History.—This mine, one of the three great mines on the Day Dawn lode, was worked without intermission from 1883 to 1912. It has produced the greatest amount of ore and gold on the field. The total output was 589,531 tons of ore for 552,851 oz. of gold, an average of almost 19 dwt. per ton. In the year 1880 the land in front of the Day Dawn P.C. was first taken up by T. Mills, who held the lease to the west known as the Wyndham Mine. The Block lease, as it was known, was for-

feited and then taken up by J. Malone and A. Young, who formed the Day Dawn Block Company and started a vertical shaft to cut the Day Dawn lode. Litigation over this lease instituted by Mills against the company resulted in a compromise by which the Wyndham lease was amalgamated with the Day Dawn Block, and the two parties formed the Day Dawn Block and Wyndham Company to work them jointly in 1882. In June, 1883, the lode was cut and a reef 6 ft. thick exposed.

PRODUCTION.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1883 ..	1,347	3,120	..	..	Up to end of year 1890, dividends reported £282,360.
1884 ..	7,255	15,957	..	..	
1885 ..	15,864	29,880	..	..	
1886 ..	20,243	37,950	..	..	
1887 ..	24,511	39,191	..	..	
1888 ..	20,267	22,761	..	..	
1889 ..	28,282	22,702	..	..	
1890 ..	13,103	7,758	..	..	
1891 ..	13,635	20,415	..	..	24,920
1892 ..	20,910	23,101	..	..	49,840
1893 ..	3,090	3,160	..	..	12,500
1894 ..	2,115	1,692	..	..	..
1895 ..	19,994	15,809	..	..	12,500
1896 ..	29,653	30,897	..	..	49,880
1897 ..	35,720	32,216	..	..	87,244
1898 ..	34,186	25,025	..	..	43,670
1899 ..	35,880	23,245	..	..	37,420
1900 ..	37,740	31,607	..	..	48,840
1901 ..	39,810	26,538	..	..	62,300
1902 ..	40,730	26,452	..	..	49,840
1903 ..	37,780	17,018	..	..	18,690
1904 ..	26,289	26,193*	..	..	12,460
1905 ..	23,056	26,443*	..	..	24,920
1906 ..	21,258	14,504	..	..	12,460
1907 ..	11,893	6,963	4,845	29,284	12,460
1908 ..	9,129	3,918	3,996	16,748	6,230
1909 ..	6,966	5,143	6,681	23,928	49,840
1910 ..	6,203	4,490	5,664	21,974	17,132
1911 ..	2,420	2,513	2,490	11,130	..
1912 ..	202	214	229	925	..

* Includes Cyanide returns from accumulated tailings.

A crushing of 32 tons taken from the area of the shaft yielded 187 oz. of gold. From 1883 to 1906 operations were a record of unexampled crushings over such a lengthy period on this field. In 1886 the mine was sold to an English company and in the following year the new company acquired the leases to the west held as the No. 3 and No. 4A West Day Dawn. A battery of 60 head of stamps was erected at Sellheim for crushing the company's ore. The pay shoot cut in the vertical shaft was the western portion of the Day Dawn P.C. shoot, and it was stoped

down to Mills United boundary. The mine was then worked from the underlie shaft from the surface (in the original Wyndham lease) and two other pay shoots were opened on this shaft. Most of the later crushings came from the shoot worked in the Day Dawn Gold Mines to the west. This shoot extended east as a narrow tongue between 1,000 and 1,200 ft. deep as far as the main underlie shaft. In 1900 the mine employed 225 men. By 1903 the ore reserves on the Day Dawn were becoming depleted, and work was started on the Talisman reef close to Mills United lease, where it had been already worked. Payable crushings were obtained from this reef from 1904 to 1906. From that year there was a gradual decline in production and the company in 1909 entered into voluntary liquidation. Tributers worked in the mine till 1912 and it was then closed down. The company held G.M.Ls. 1807, 1808, and 1809, an area of 100 acres.

Underground Workings (Summary).—There were three working shafts. No. 1, on the east boundary, cut the lode at 475 ft. and an underlie shaft was sunk on it to the boundary of Mills United Mine. The six upper levels from this shaft all connect with the main underlie shaft. No. 2 shaft, further to the west, has been sunk on the lode from the outcrop to the boundary of Pfeiffer's Mine. The bottom is at a depth of 1,918 ft. This shaft cut the north-west corner of the shoot worked in No. 1 shaft at just over a depth of 100 ft. At 500 ft. a small shoot extending to the boundary of the Church Land was worked. Below that no stoping was done till a depth of 1,300 ft. was reached. Old reports state that at No. 4 (v.d. 711 ft.), there was a low-grade reef 8 ft. thick left, but no particulars as to value or dimensions are given. Below 1,300 ft. the reef was stoped out down to Pfeiffer's boundary. Below this a footwall reef was worked in the lower levels.

No. 3 shaft further to the west is vertical to a depth of 560 ft. From there another shaft follows the lode almost to Pfeiffer's. This shaft intersected a shoot between a depth of 1,000 and 1,200 ft., and this has been worked to the western boundary. The old workings of the No. 3 and No. 4A Day Dawn West were in the south-west corner of the lease.

Day Dawn Church Land G.M. Company.

This company, formed in 1887, acquired the right to mine under the freehold land occupied by the Church of England, consisting of 2 acres 1 rood. This land was surrounded by the Day Dawn Block and Wyndham lease, and negotiations for working the area through one of that company's shafts being unsuccessful, a two-compartment shaft was sunk from the surface in 1896 to a depth of 810 ft. The lode was unpayable where

intersected, but in sinking on the lode a block of payable ore was found in the north-west corner. The lode in the greater part of the area was unpayable, as the pay shoot worked in the surrounding mine ended a few feet inside the south-east corner of the freehold. Following are the complete returns:—

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1899	5,572	6,340	3,900
1900	5,905	3,581	5,200
1901	403	159	..

PFEIFFER'S DAY DAWN GOLD MINES.

History.—This mine was formerly known as the Day Dawn Freehold Consolidated Gold Mines. The original company was formed in 1896 and acquired freehold land to the west of Mills United and to the north of the Day Dawn Block and Wyndham. The streets separating the freehold allotments were taken up by the Mills United Company, and for some years this proved an obstacle to working parts of the lease. The main shaft was commenced in the year 1896 and cut the hanging-wall reef at a depth of 1,827 ft. and the footwall reef at 1,989 ft. The first crushings were recorded in 1900 and for two years the mine made a small profit. After a period of idleness the company was reconstructed in 1906 as Pfeiffer's Day Dawn Gold Mines, and it acquired the streets held by Mills United. Subsequently the company held 68 acres under G.M.Ls. 2404 and 2405. During 1907 and 1908 operations were payable, but from 1909 there was a shrinkage both in output and value of ore. Prospecting in the west levels and in following the reef down to a depth of over 2,600 ft. did not open up any payable ore, and in 1914 the company went into liquidation and surrendered the leases. Part of the area was applied for in 1915 by Mills D.D. United G.M. Company.

PRODUCTION.

The following are the complete returns:—

DAY DAWN FREEHOLD CONSOLIDATED.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1900	1,797	1,703	..
1901	15,815	11,186	15,000
1902	5,503	3,211	..
1903	1,031	412	..
1904	151	89	..

There were no returns for 1905 and 1906.

PFEIFFER'S DAY DAWN GOLD MINES.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1907 ..	6,196	5,611	8,208	27,797	..
1908 ..	5,095	3,418	3,914	15,885	..
1909 ..	978	487	515	2,214	..
1910 ..	254	50	96	266	..
1911 ..	865	221	871	1,630	..
1912 ..	798	451	367	1,890	1,031
1913 ..	435	222	399	1,127	..
1914 ..	47	16	21	70	..

Underground Workings.—A vertical four-chambered shaft was sunk to below No. 4 level (2,104 ft.). It cut the hanging-wall lode at 1,827 ft. and the footwall lode at 1,989 ft. Most of the payable ore came from the hanging-wall reef and was a continuation of a pay shoot worked above in the Day Dawn Block and Wyndham, the pitch of the shoot continuing north-west down to No. 4 level, where the pay ore cut out. Down to No. 4 the levels are connected by crosscuts to the main shaft. From the end of No. 4 crosscut a shaft has been sunk on the hanging-wall lode to a depth of 2,619 ft. (No. 10 level) and levels driven up to 500 ft. in length. Crosscuts at Nos. 5, 8, 9, and 10 levels were driven to the footwall lode and short levels opened, but none of these prospecting efforts encountered payable ore. No. 2 west level has been driven to the boundary of the Day Dawn Gold Mines. No. 4A east level connects with Mills United No. 12 (v.d. 2,040 ft.).

DAY DAWN GOLD MINES.

This Company held G.M.L.'s 1882, 1883, and 2052, aggregating an area of 69 acres 2 roods lying on the west side of the Day Dawn Block and Wyndham and Pfeiffer's D.D. mines. Part of this area was originally held by the Day Dawn Consols Company and the vertical shaft was sunk to 500 ft. The lease was then forfeited and taken up by a local company, the Day Dawn Freehold Extended, who continued sinking the shaft and worked the mine till 1898. It was then taken up with additional ground and worked by the Day Dawn Gold Mines Company. The vertical shaft cut the lode at 1,130 ft. and was continued to 1,250 ft. No. 1 level was driven west from the shaft 550 ft. with only occasional patches of low-grade quartz showing. No. 1 east struck a payable reef at 380 ft. from the shaft. The underlie shaft was sunk to a depth of 1,140 ft. with no ore showing. No. 2 east level cut the pay ore at 420 ft. in. As the shoot was pitching north-east an underlie shaft was sunk near the eastern

boundary from which the shoot was worked to a depth of 1,600 ft., where it passed into the Day Dawn Block and Wyndham Mine. This shoot was worked back to the southern boundary of G.M.L. 1882 east of the vertical shaft and furnished some of the finest specimens of free gold found on the field. From 1905 to 1907 the Company did considerable prospecting work for the Talisman reef without success, a monkey shaft being sunk 780 ft. from No. 8 level. In 1910 the Company acquired Wallis Day Dawn lease on the west and drove their No. 2 level (v.d. 1,200 ft.) into that ground without striking payable ore. In 1911 the mine was closed down.

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1895*	90	52	..
1896*	..	..	..
1897*	333	131	..
1898*	682	838	..
1899	4,076	5,197	8,582
1900	4,953	7,024	10,298
1901	10,404	11,919	15,447
1902	12,437	13,144	21,200
1903	13,647	11,712	12,469
1904	6,420	5,124	2,492
1910	186	76	..

* Returns when held as Day Dawn Freehold Extended Mine.

DAY DAWN NO. 3 WEST MINE.

This was one of the original mines on the outcrop of the Day Dawn lode adjoining the Day Dawn Block and Wyndham Mine on the west. Operations near the surface were unsuccessful and the mine lay idle for some years. Between 1887 and 1895 the lode was worked to a depth of 600 ft. A small shoot of ore pitching to the north-east was stoped out between No. 3 level (383 ft.) and No. 6 level (615 ft.) on the west side of the shaft.

RETURNS.

Year.	Ore Raised.	Gold.
	Tons.	Crude oz.
1887	399	1,408
1888	996	4,771
1892	78	81
1893	900	867
1894	179	128
1896	36	11

The underlie shaft was sunk several hundred feet below No. 6 but no further ore was found. Some very rich ore was found,

as will be seen from the returns. The lease was in 1896 amalgamated with the Day Dawn No. 4A West and became known as the Day Dawn North Australian, but there were no further returns. In 1899 the area was taken up by the Day Dawn Block and Wyndham Company.

Day Dawn No 4A West Mine.

This is the original mine on the Day Dawn lode immediately to the west of No. 3 west. This mine worked the upper part of the shoot which was struck at No. 3 level in the No. 3 west mine. This shoot started at 30 ft. from the surface on the west side of the shaft and cut out on No. 3 east level (v.d. 383 ft.). The shaft was sunk on the lode to a depth of 700 ft. and three levels driven below No. 3 without any payable ore. In 1896 it amalgamated with the No. 3 West mine and was known as the Day Dawn North Australian Mine. In 1899 the area was taken by the Day Dawn Block and Wyndham Company under G.M.L. 1807.

Returns.

Year.	Ore Raised.	Gold.
	Tons.	Crude Oz.
1887	661	1,516
1888	1,162	3,528
1891	554	1,484
1892	210	443
1894	554	639
1895	40	71

Day Dawn No. 4B West Mine.

This mine, adjoining No. 4A West on the west, was worked in the early days but was a failure. It was again worked in 1891 and 1892 with no better results. A shaft has been sunk on the lode to a depth of over 500 ft. Three levels were driven. From No. 2 level (v.d. 325 ft.) a small crushing was put through but proved unpayable.

Day Dawn No. 5 West Mine.

This mine included the original leases No. 5, No. 6, and No. 7 west. These were failures near the surface and were eventually closed down. No. 6, re-worked in 1888, yielded 930 oz. of gold, the ore coming from between No. 1 level (v.d. 315 ft.) and No. 3 level (v.d. 379 ft.) on the west side of the shaft. There were no returns from No. 7 West Mine. No. 5 West Mine, worked from 1894 to 1897, gave small returns. These workings were considerably extended when the land was later taken up by Wallis' Day Dawn G.M. Company.

RETURNS.

Year.	Ore Raised.	Gold.
	Tons.	Crude oz.
1894	672	688
1895	179	170
1896	365	526
1897 ..	568	908

WALLIS' DAY DAWN MINE.

This mine, situated on the western extension of the Day Dawn lode, immediately to the west of the Day Dawn Gold Mines, was taken up under G.M.L.'s 1910 and 1911 by Wm. Wallis and John King respectively, in 1902. The same year a company was formed to work them known as Wallis' Day Dawn Gold Mines, Limited. The area of the two leases was 50 acres. They included part of the leases originally held as No. 5, No. 6, and No. 7 West Day Dawn and were taken up for the purpose of testing the lode below those workings. Operations were commenced in July, 1902. The No. 5 underlie shaft was sunk to a depth of 700 ft. and the No. 6 shaft to a depth of 760 ft. The two shafts were connected by No. 8 level (v.d. 688 ft.). Nos. 8 and 9 levels explored the fissure for 350 ft. west of No. 6 shaft. The only payable ore found was between a depth of 500 ft. in the No. 5 shaft and the No. 8 level at No. 6 shaft. A crosscut 140 ft. long was driven into the hanging-wall country from the plat (No. 6 shaft) at the 316-ft. level. The No. 7 shaft (7 chains west of No. 6) was sunk to a depth of 520 ft. on an unpayable fissure. Ore of good quality was found occasionally as small lenses but the fissure was reported to be too narrow and the ore too variable in quality to anticipate any improvement in the deeper ground, so operations were discontinued at the No. 9 level (v.d. 748 ft.). In 1908 the Company went into liquidation and in 1910 the leases were purchased by the Day Dawn Gold Mines, who then did some prospecting work on the 1,200-ft. level extended from that mine.

RETURNS.

Year.	Ore Raised.	Gold.
	Tons.	Crude oz.
1905	681	1,075
1906	46	42
1907	120	37

PLANT'S DAY DAWN GOLD MINES, LIMITED.

In 1902 a deep shaft to cut the Day Dawn lode was commenced on the leases held by this Company. Work was

continued until 1906, when a depth of 1,200 ft. was attained and the work was then stopped. The position of the shaft is near the Showground. The Company held G.L.'s 1702 and 1703; area, 50 acres *ex.* freeholds.

No. 2 South-East Day Dawn (Old Mine).

The Company held a lease (G.M.L. 1487) of 24½ acres lying between the Day Dawn P.C. and the Victory leases. It was in this area that the Brilliant and Day Dawn lodes were expected to junction near the surface. The ground was worked from the early days by prospectors with poor results near the surface. The Company put down two shafts. No. 1 shaft near the centre of the lease was sunk over 1,100 ft. vertically. At 326 ft. a vein dipping north-east was cut. A little stoping was done on this close to the shaft but the find was apparently of no value. At 1,115 ft. a vein dipping north-west at 45 deg. was intersected. A level was driven 160 ft. and an underlie shaft sunk 160 ft. No payable ore was struck. A crosscut was put in 200 ft. in the hanging-wall and 140 ft. in the footwall without result.

In the No. 2 shaft near the Victory lease, a reef dipping north-west was cut at 112 ft. An underlie shaft was sunk to a depth of 138 ft. below the surface. No. 1 level (112 ft.) was driven 240 ft. and No. 2 (138 ft.) about 160 ft., and a little stoping done on each level. This mine, situated close to the Day Dawn and Brilliant lodes, has been one of the notable disappointments of the field, for both lodes apparently die away to small poor veins in this locality. The only recorded return is for the year 1893, 120 tons of ore yielding 292 oz. of gold.

Day Dawn School Reserve Mine.

The history of this mine illustrates the uncertain distribution of ore values on the Day Dawn lode. The big ore shoot worked in Mills' United and the Day Dawn P.C. extended right along the western and part of the southern boundaries of this Reserve, but operations here were a total failure. The area of the School Reserve is 5 acres. The land was first pegged out in 1885, but it was not till 1887 that it was declared available for mining, and it was then taken up by the D.D. School Reserve G.M. Co. at an annual rental of £900 per acre. The following year the rental was reduced to £1 per acre after the lease was forfeited, the Company again securing it at the nominal rental. A shaft was put down, to the south of the Reserve, in the Day Dawn P.C. lease to a depth of 1,026 ft. A north crosscut

intersected the lode within the Reserve. No. 1 level (1,026 ft.) was driven to the west boundary. An underlie shaft was sunk on the lode to a depth of 1,200 ft. and No. 2 level (1,152 ft.) was connected to Mills' United workings. No payable ore was found. A rise put up from Mills' United workings in the north-east corner of Reserve on the main hanging-wall lode was equally unsuccessful in locating pay ore. This rise is connected to the bottom of the underlie shaft. The only crushing obtained was in 1893, when 87 tons of ore yielded 13 oz. of gold. The Company obtained exemption from labour conditions in 1895, and it has been closed down since then.

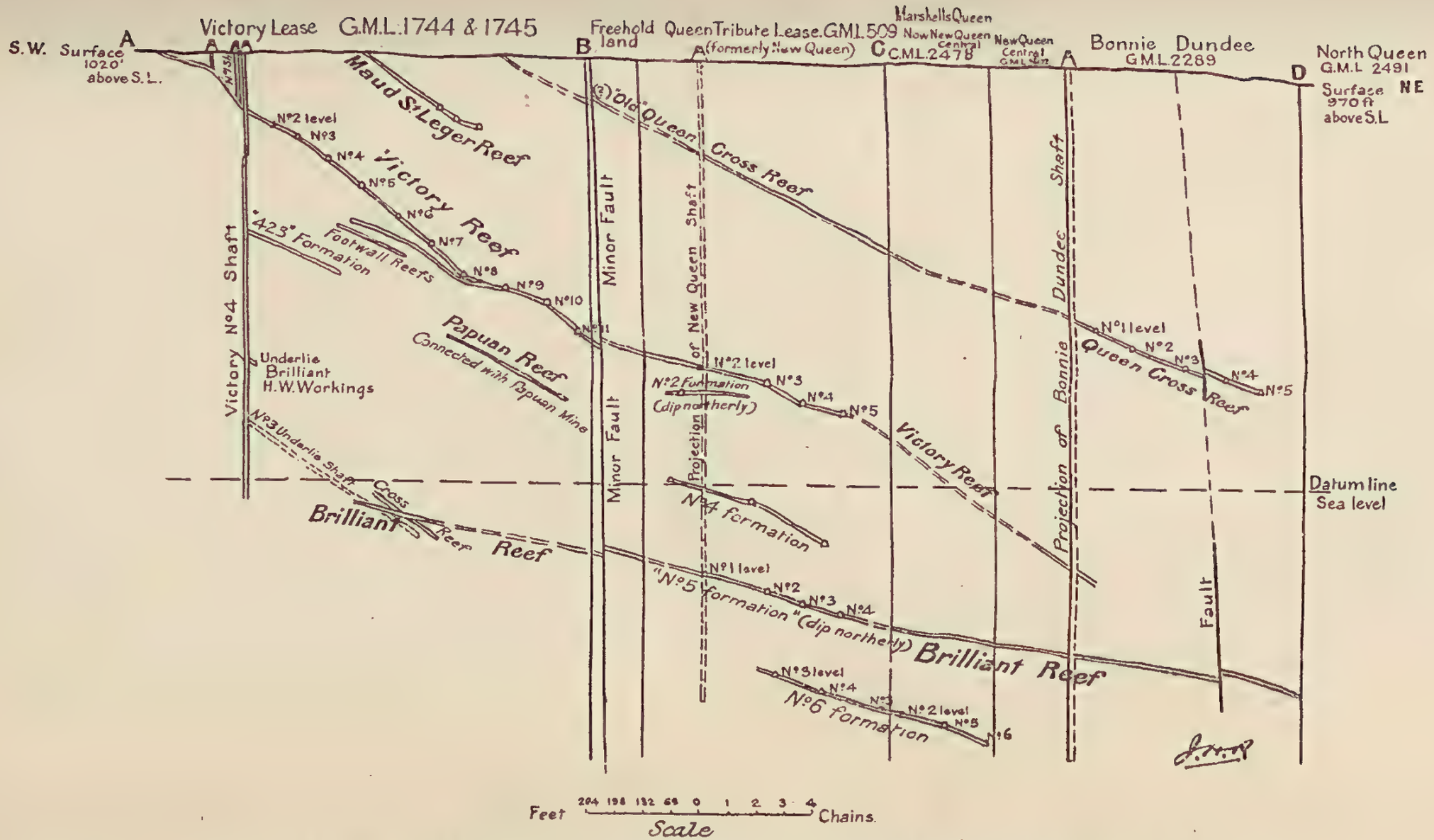
Grand Secret Mine.

From 1876 to 1880 a small auriferous vein known as the Grand Secret was worked just to the north of the western extremity of the Day Dawn lode. The strike of vein according to Dr. R. L. Jack's report is 110 deg. east of north and the dip northerly at an angle of 45 deg. It was worked in three claims, the P.C., No. 1 East, and No. 1 West, and they are reported to have won about 900 oz. of gold although the reef did not average 6 in. in thickness. After this work the ground was idle until 1895, when it was taken up by the Grand Secret and Day Dawn United G.M. Company, Limited. A vertical shaft was sunk 80 ft. and an underlie from the bottom followed the vein to a depth of 170 ft. Two levels were put in on the west side of shaft, but operations did not disclose anything promising, and the mine closed down in 1897. The returns were—1895, 38 tons of ore for 56 oz. gold; 1896, 60 tons of ore for 80 oz. gold.

MINES ON THE BRILLIANT AND QUEEN LODES AND ASSOCIATED REEFS.

This group includes the mines situated in the Queenton area of the field lying to the east of the city. The Brilliant lode has been the mainstay of most of these, but a number of smaller reefs associated with that lode, such as the "New" Queen Cross, Victoria and Queen, and the Caledonia, and cross reefs such as the Victory, Maude St. Ledger, "Old" Queen Cross, and the Just-in-Time, have contributed wholly or partly to the returns from some (*see* sections of workings A, B, C, D, and G, H.). The majority of these mines have been closed down within the last five years, but in 1916 the following were working:—Brilliant Extended, Brilliant Deeps, Victory, Queen Tribute* (formerly New Queen), New Queen Central,* and Bonnie Dundee.

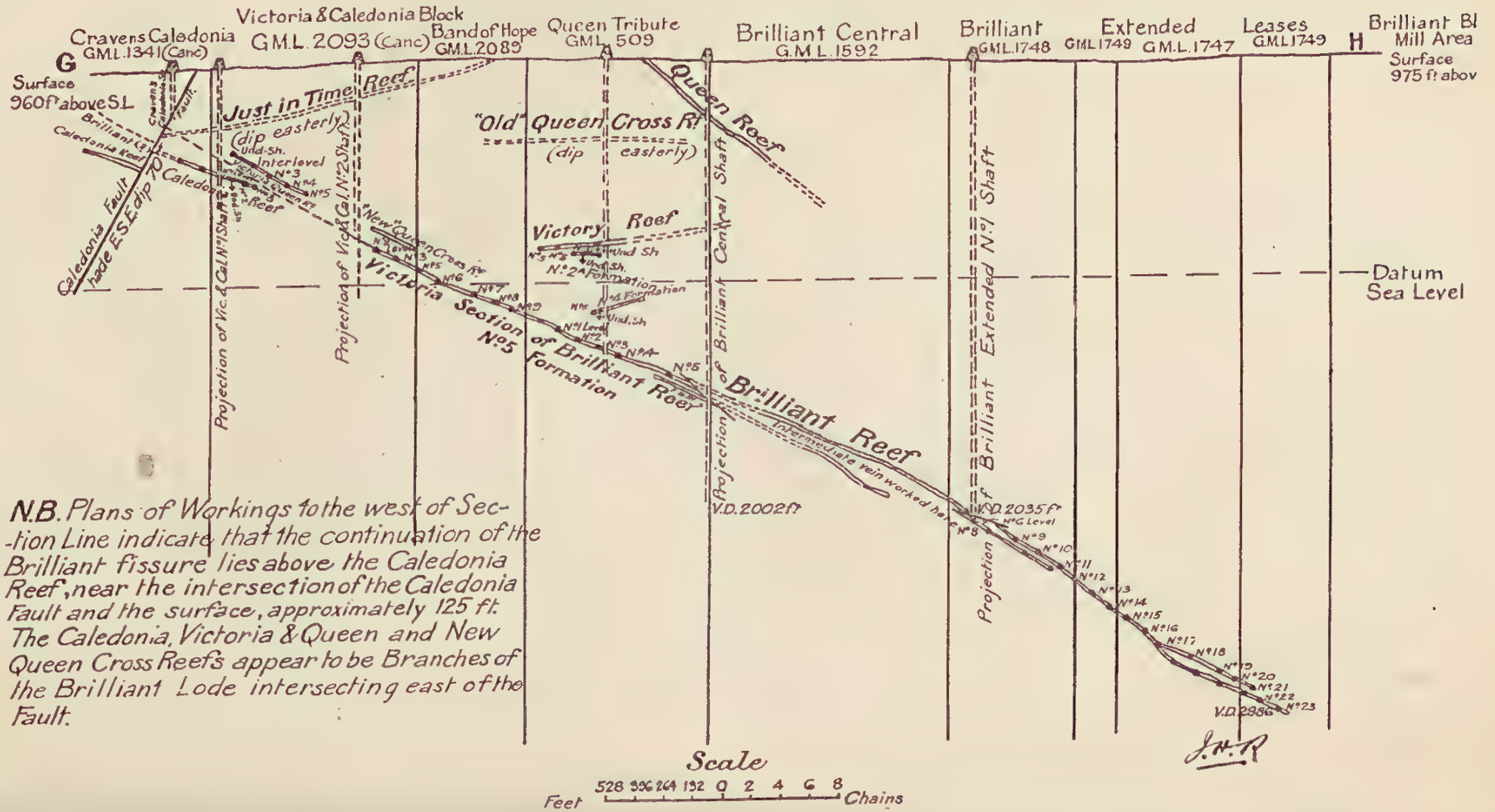
* Since closed down.—J.H.R.



Vertical Section showing positions of reefs along section line A.B.C.D.
(see plan of leases) ***plotted from plans of Workings***

There are two main reef systems-one dipping north, the other dipping E. N. E

Vertical Section along line G.H. (see plan of leases) showing the Brilliant & associated reefs. Plotted from plans of Workings



N.B. Plans of Workings to the west of Section Line indicate that the continuation of the Brilliant fissure lies above the Caledonia Reef, near the intersection of the Caledonia Fault and the surface, approximately 125 ft. The Caledonia, Victoria & Queen and New Queen Cross Reefs appear to be Branches of the Brilliant Lode intersecting east of the Fault.

Brilliant Extended Mine.

Situation, Leases, &c.—The mine is situated near the north-east corner of the city boundary. It adjoins the Brilliant Deeps Mine on the east and the Brilliant Central Mine on the north. The Brilliant Extended G.M. Campany, Ltd., holds G.M.L. 1747, 25 acres; G.M.L. 1748, 25 acres; G.M.L. 1749, 25 acres; and G.M.L. 2409, 50 acres. The manager is Mr. Peter Kerr.

History and Production.—The operations in this mine have been exclusively on the Brilliant and several branch reefs, but before a company was formed to work these the ground had been worked near the surface from early days. The present leases include the workings on the Home Rule and St. Patrick reefs, the latter of which proved to be the most productive reef on the field before the discovery of the Day Dawn lode. The original lease of the Extended Mine, taken up in 1891 as a result of the boom following the discovery of the Brilliant lode in the Brilliant P.C. Mine, comprised less than 16 acres, but the surrounding ground has gradually been leased until the company now holds 125 acres exclusive of the Columbia lease. The Home Rule vertical shaft, sunk to a depth of 600 ft., was enlarged and continued as the present No. 1 shaft. The reef was reached in 1894 at a depth of 2,035 ft., and crushings have been regular since. The early crushings from the western workings were poor for this field, averaging from 10 dwt. to 12 dwt. a ton. The eastern workings were extended and encountered richer ore, but owing to the difficulty of ventilating the workings the company in 1901 entered into an agreement to pay half the cost of sinking the Bonnie Dundee No. 2 shaft, the Extended Mine to have the use of two compartments. The eastern workings were then connected to this shaft by a crosscut and No. 3 underlie shaft was sunk. This opened up higher grade ore and the first dividend was paid in 1902. In 1905 the Enterprise Mill and cyanide plant were purchased and this effected a reduction in cost of treatment from 17s. 6d. to 11s. per ton, a big item in an annual turnover of 40,000 tons. In 1909 the mine reached its zenith of production, 61,300 tons of ore, and employed 430 men. On the decline of Mills' United this mine has been the premier producer on the field since 1910. The eastern workings in 1915 were down to the No. 23 level at a depth of 2,986 ft. and the No. 3 underlie shaft was continued to 3,045 ft., the greatest depth attained in mining in Queensland. In the bottom levels the ore has declined in value and during 1916 operations have been carried on at a financial loss.

PRODUCTION.

The following are the complete returns to 1916:—

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1894 ..	367	174	..	..	..
1895 ..	1,750	971	..	..	..
1896 ..	16,032	9,217	..	..	..
1897 ..	21,219	11,823	..	..	..
1898 ..	5,679	3,340	..	..	..
1899 ..	3,325	1,914	..	..	..
1900 ..	11,175	7,832	..	..	..
1901 ..	10,305	5,775	..	..	..
1902 ..	12,134	7,738	..	..	6,250
1903 ..	17,013	7,999	..	..	12,500
1904 ..	28,654	11,350	..	..	..
1905 ..	30,286	14,945	..	..	..
1906 ..	47,429	19,627	..	..	37,500
1907 ..	46,322	12,346	41,100	84,591	..
1908 ..	51,225	13,616	64,508	112,784	6,250
1909 ..	61,327	12,565	77,637	127,379	25,000
1910 ..	49,050	13,224	80,116	127,384	18,750
1911 ..	53,562	13,161	64,848	113,084	12,500
1912 ..	34,240	7,871	37,276	67,182	..
1913 ..	26,739	9,053	38,215	69,536	12,500
1914 ..	19,075	6,995	29,276	53,665	6,250
1915 ..	14,233	5,486	26,300	45,815	12,500
1916 ..	6,359	4,166	16,239	29,178	..

Reefs Worked.—The bulk of the ore won from the mine has been obtained from the main reef of the Brilliant lode. In this mine it is called the footwall reef on account of the rather extensive workings on a hanging-wall reef in the lower workings. On the east side it can be traced upwards to the surface and is known as the hanging-wall reef in the Brilliant Central, the No. 5 formation in the Queen Tribute (New Queen), and as the Victoria in the Band of Hope and Victoria Mines, in the latter of which it outcrops. (*See* section G.H.) On the west side of the mine it can be traced successively upwards through the Brilliant and St. George, Brilliant P.C., and Victory Mines. In addition to this reef several branch reefs have been worked, the more important being a footwall branch between No. 4 and No. 10 levels and a hanging-wall branch between No. 17 and No. 22 levels.

Underground Workings.—The mine has been worked from two surface shafts. No. 1 shaft, from which the western portion was worked, cut the reef at No. 4 level (2,035 ft..). The western levels down to No. 4 reach the boundary of the Brilliant Block, where they are connected to workings in that mine. Above No. 4 the reef was worked by three crosscuts. The reef has been worked here from the Brilliant and St. George boundary to a

BRILLIANT EXTENDED MINE
PLAN OF WORKINGS

Taken from Mine Managers Plans

Scale

Feet 0 40 80 160 240 Feet

Stoping Reference

Main Reef

,, Hanging Wall Reef

Footwall & Hanging Wall Branch Reefs

PLAN
OF
Brilliant Extended Leases

Scale

Chains 0 4 8 16 24 Chains

GML1627 *Brilliant Block*

GML2409 *Brilliant Extended* 50 0. 0

GML2411 *Brilliant Deeps*

GML.1749 *Brilliant Extended* 25. 0. 0

GML.2518 *Brilliant Extended* 28. 2. 32.

GML1747 *Brilliant Extended* 23 0 0

GML.1748 *Brilliant Extended* 25. 0. 0

GML2289 *Bonnie Dundee*

GML1592 *Brilliant Central*

Vertical Section along N°3 Underlie Shaft

Scale

Feet 0 80 160 240 320 Feet

BRILLIANT DEEPS

BRILLIANT CENTRAL

BRILLIANT & St GEORGE

Plan 8.

depth of 2,200 ft. From No. 4 level, 520 ft. east of No. 1 shaft No. 2 underlie shaft goes down to No. 10 level (2,270 ft.). No. 8 level from this shaft continues easterly to No. 2 vertical shaft in the Bonnie Dundee lease at a depth of 2,162 ft. It is from No. 2 shaft that the eastern portion of the mine has been worked to a depth of 3,000 ft. To improve the ventilation here the connecting levels with No. 1 shaft have been muzzled and the upcast air goes through the Brilliant and St. George workings to the surface. From No. 8 level, 630 ft. west of No. 2 (Bonnie Dundee) shaft, the main underlie shaft (No. 3) has been sunk to a depth of 3,045 ft. Levels have been opened about every 100 ft. down the lode, the bottom one (No. 23) being at a depth of 2,986 ft. The eastern levels have opened up the lode for 500 ft. east of the shaft. No. 18 east was extended as a prospecting level for 900 ft., the last 400 ft. being on a narrow unpayable vein. On the west side of the shaft No. 9 level connects with the No. 2 underlie shaft, No. 12 is connected to No. 2 east in the Brilliant Deeps. Below No. 14 the levels continue to the boundary of the Brilliant Deeps, the longest being No. 17 which is in 800 ft.

The hanging-wall workings below No. 16 level are connected to the main workings by crosscuts on the east side of the shaft.

Pay Shoots.—The deepest portion of the largest and most productive ore-shoot on the field has been worked. This, the main Brilliant ore shoot, has been worked from a depth of 550 ft. in the Victory Mine, where it averaged 3·4 oz. of gold to the ton, showing a fluctuating but gradual decrease in value with depth until in this mine it has averaged about 12 dwt. per ton between the depths of 1,900 ft. and 2,900 ft. The pitch of the shoot is easterly with increasing depth and the average stope length below a depth of 2,000 ft. is about 900 ft. Values have fluctuated a great deal, for above 2,500 ft. patches of the ore have been unpayable, while 1-oz. stone has been won below that depth. The shoot may be considered to end at a depth of about 2,900 ft., for the reef as a whole is then too low grade to pay although there are a few comparatively rich sulphide streaks. Payable ore on the branch reefs is confined to the area of the main pay shoot.

Geological Features.—There is an absence of any noteworthy geological detail. The country rock is normal granodiorite, and there appears to be an entire lack of the diorite-porphyrite dykes so characteristic of the mines immediately to the west. Two small faults were observed. The most easterly cuts through the No. 3 underlie shaft near the No. 12 plat. The strike is north-west to south-east and it heads north-east at an

Bonnie Dundee
Brilliant Extended
No. 2) Shaft.

Mill and
Aerial Tramway

Brilliant
Extended Mine.
No. 1 Shaft.

Cyanide
Works.

MINE AND WORKS OF THE BRILLIANT EXTENDED GOLD MINING COMPANY.
Showing Aerial Tramway.

Plate 30.

average angle of 45°. It is a normal fault, the reef on the eastern side being thrown up 10 ft. in No. 10 east level. This fault has been traced into the Brilliant Central Mine. The strike, almost at right angles to the pitch of the ore shoot it traverses, clearly refutes any suggestion of a genetic relationship with the ore. Within 100 ft. west of No. 2 underlie in the upper levels an almost vertical fault is present. This has been better seen in the Brilliant Central Mine, where the reef is thrown down 7 ft. on the west side. In the Extended Mine this fault traverses the poorest portion of the ore-shoot.

The lode fissure at No. 23 level (2,986 ft. v.d.), has every indication of surviving to great depth. The fissure there is 4 ft. to 6 ft. wide with well-defined slickensided walls. There has been a preponderant deposition of silica, the decrease in the amount of metallic sulphides being very marked. Whenever present the latter are in streaks, suggesting a reopening of the reef and that, at the present depth of 3,000 ft., conditions were not favourable for the deposition of gold and associated minerals from the original vein-forming sulphide solutions.

Recent Operations.—The ore reserves on both the Brilliant footwall or hanging-wall reefs are almost exhausted. Further development work ceased with the sinking of the underlie shaft to a depth of 3,045 ft. the sink of which showed up to 2 ft. of white quartz. The accummulation of water from the shallower mines has become a serious problem and the water had flooded the three lowest levels in March, 1916. For the fortnight ending 15th March, 1916, 1,548,338 gallons of water were hauled and the average figures are close up to that total. The latest operations have been confined to Nos. 17, 18, 19, and 20 levels, and the stopes there have been supplying most of the recent tonnage. No. 18 H.W. level and No. 19 and 20 F.W. levels have also been extended to approximately 500 ft. east from the shaft, and the stopes near the ends have supplied the balance of ore raised. Above these levels operations have practically ceased. The latest development work is the crosscut driven into the footwall country from the Bonnie Dundee crosscut, 110 ft. east of No. 4 underlie shaft, at a depth of 2,162 ft. To the end of 1916 it had been driven nearly 400 ft. without result. The company recently took up the Columbia Mine, G.L. 2518, on which a vertical shaft at least 2,200 ft. deep is situated. If developments in the Bonnie Dundee Mine continue favourable this lease might be reworked.

Brilliant Deeps Mine.

Situation, Leases, &c.—The mine is situated on the eastern side of the city, the western workings occupying portion of the

north-east corner of the city municipal area. On the south it adjoins the Brilliant Block Mine and on the east the Brilliant Extended Mine. The Brilliant Deeps, Limited, leases comprise G.M.L. 2411, 50 acres; G.M.L. 2479, 43 acres, and G.M.L. 2480, 20 acres 2 roods 33 perches. The manager of the mine is Mr. T. Webb.

History and Production.—The ground was first taken up in 1891, the mine then being known as the Brilliant Extended Block. The first leases comprised an area of only 31 acres, since

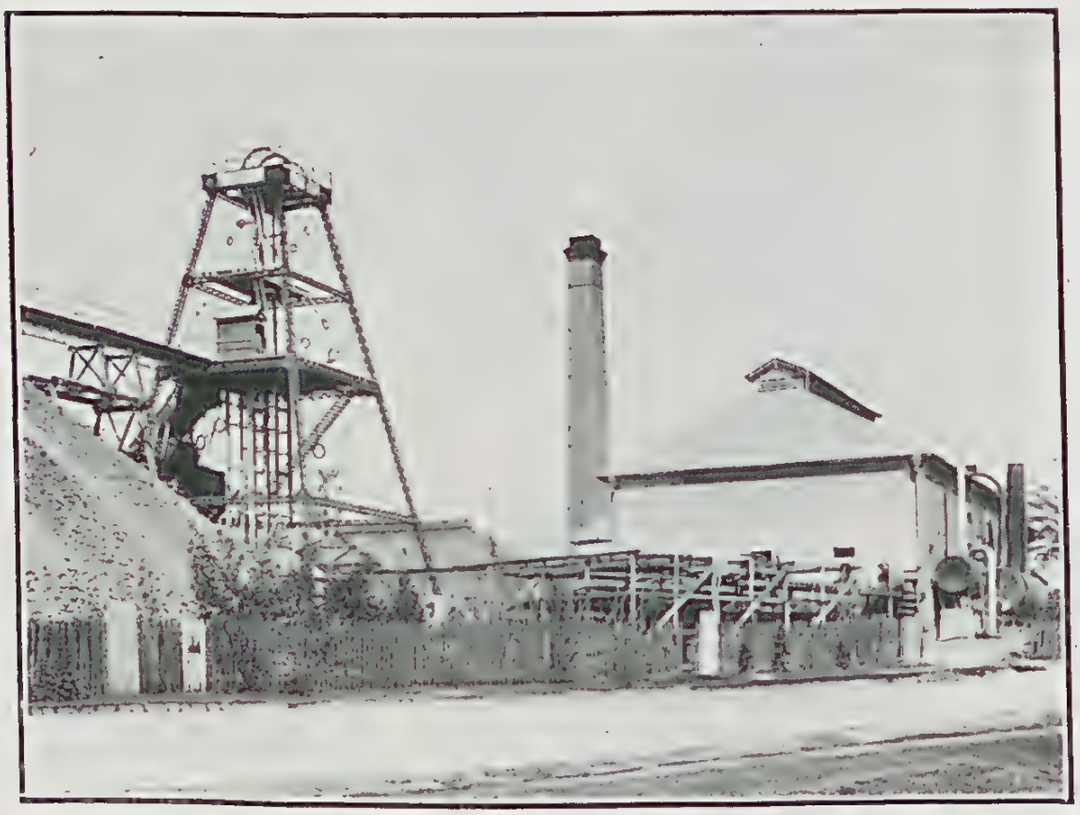


PLATE 31.—BRILLIANT DEEPS MINE.
To end of 1916: Ore raised 39,133 tons, value £151,748; dividends nil.

increased to 113 acres. A three-compartment vertical shaft was sunk to cut the reef, the estimated depth being over 2,000 ft. This is the deepest vertical shaft (2,552 ft.) on the field, and financial troubles delayed the completion of the work. In 1896 lack of capital necessitated a reconstruction of the company, which became the Brilliant Deep Levels G.M. Company. That year the shaft was carried to a depth of 2,550 ft. and intersected the lode at 2,250 ft. An explosion at the shaft collar delayed operations on the reef, which were ultimately started in 1897. The Brilliant lode, where intersected, carried a reef varying from 2- to 4 ft. thick, but it was unpayable. Up to the year 1903 the eastern ground was opened up, No. 2 east level being driven to the boundary of the Brilliant Extended and the underlie shaft

sunk on the lode to a depth of 2,615 ft., but no payable ore was found. In 1904 operations were suspended for a time owing to the difficulty of ventilating the workings. In 1907 the company was reconstructed as the Brilliant Deeps, Limited, and prospecting on the lode in the western ground was proceeded with. This met with greater success, for the "hanging-wall" reef was struck in No. 2 west level, and from 1908 onwards, after a period of twelve years' prospecting work, regular crushings were obtained. In 1911 the "footwall" reef was found in extending No. 4 level west at a depth of 2,540 ft. Most of the ore since then has been obtained from this reef, which has been worked to a depth of 2,811 ft. In 1914 the "hanging-wall" workings were connected to the Brilliant Block workings for the purpose of ventilation and this has enabled operations to be carried out on the reef there simultaneously with work on the "footwall" reef.

PRODUCTION.

The following are the complete returns:—

From 1897 to 1899, 344 tons of ore were crushed for a return of 69 oz. of gold. From 1900 to 1907 there were no returns.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1908 ..	100	81	37	331	..
1909 ..	1,246	906	2,146	5,381	..
1910 ..	2,860	1,967	4,205	11,254	..
1911 ..	941	735	1,455	4,076	..
1912 ..	3,887	3,311	13,321	24,902	..
1913 ..	8,257	4,826	18,285	35,192	..
1914 ..	9,748	5,261	15,185	33,453	..
1915 ..	7,308	3,386	9,636	21,227	..
1916 ..	4,442	2,370	7,776	15,931	..

Underground Workings.—A three-chambered vertical shaft cuts the Brilliant lode at a depth of 2,250 ft. The shaft is continued to 2,552 ft., and the workings on the lode are connected to it by crosscuts at No. 1 (v.d. 2,349 ft.) and No. 2 (v.d. 2,413 ft.) levels. From No. 2 level an underlie shaft has been sunk on the lode to No. 5 level (v.d. 2,609 ft.). No. 2 east level was driven 1,120 ft. to the boundary of the Brilliant Extended, where it is connected to No. 12 level in that mine. No. 4 and No. 5 east levels are 160 ft. long. The western levels connect the "hanging-wall" and "footwall" workings to the main shaft. From No. 2 west a crosscut 500 ft. in length connects to No. 1 level (v.d. 2,413 ft.) on the "hanging-wall" reef. An underlie shaft has been sunk on this reef for 160 ft., which is dipping to the north-west. No. 1 and No. 2 west levels are 180 and 230 ft.

respectively in length. No. 2 east is in 90 ft. and No. 3 east (v.d. 2,432 ft.) 140 ft. The reef has latterly been worked from a winze sunk from a point in the crosscut, 180 ft. east of the underlie shaft. The "footwall" reef workings, from which the bulk of the ore has been obtained, are connected to the main workings by a crosscut from No. 4 west level (v.d. 2,554 ft.). An underlie shaft has been sunk to a depth of over 2,800 ft. Most of the pay ore was won from the northern side of this shaft. No. 5 east level connects with No. 5 west on the main reef. Nos. 6 and 7 east have been driven 200 ft. No. 8 east (v.d. 2,771 ft.) is in 180 ft. No. 9 (v.d. 2,811 ft.) is now being opened up. No. 4 west level has been driven into the ground of the Brilliant Block, where it is connected by a crosscut to an underlie shaft sunk to a depth of 2,544 ft. This is now used as an air way. No. 5 and No. 6 west have been driven 180 ft. The mine is working under great economic disability owing to the distance of the pay ore on this reef from the main shaft and the extra haulage. It has three haulages before it reaches the surface—firstly to No. 4 level by air winch, then trucked nearly 500 ft. to the main underlie shaft, hauled again to the No. 2 crosscut, thence trucked to the vertical shaft. An alternative scheme is to drive a crosscut 200 ft. west from the main shaft to cut the reef at a depth of approximately 2,400 ft., to which point a rise has been put up from No. 4 plat. This would obviate one haulage.

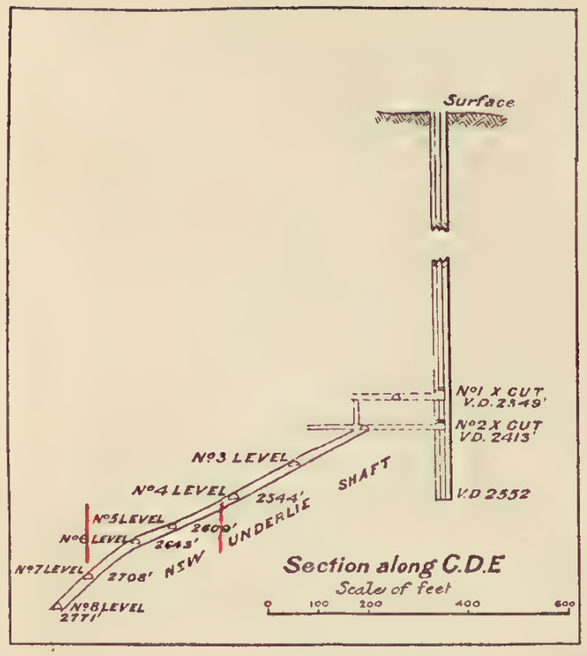
Reefs Worked.—The Brilliant reef in this mine dips north-westerly at an angle of 35 degrees. The reef has been explored laterally for 1,200 ft. between the depths of 2,350 ft. and 2,600 ft., but has never revealed payable ore. Trial crushings from No. 1 and No. 2 levels averaged 5 dwt. of gold per ton. The "hanging-wall" reef dips to the north-west at a small angle (maximum about 15 degrees) and at times becomes almost horizontal. The strike follows roughly the line of a semi-circle, and followed to the east towards the main shaft dips to the north. It is apparently a flat offshoot of the Brilliant lode, which has been traced 600 ft. west of the main shaft, where a belt of crushed country rock, seen in No. 2 crosscut, indicates the line of movement forming the Brilliant fissure. The "footwall" reef dips due west at an angle of 30 degrees and lies under the western extension of the Brilliant fissure. This reef has supplied most of the ore won.

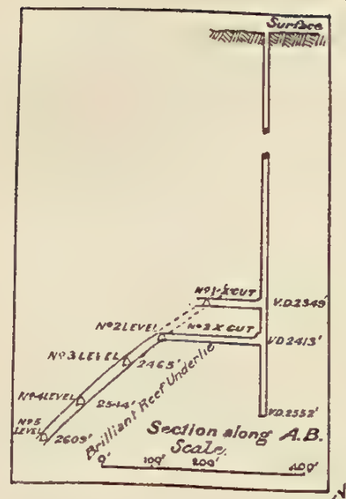
Pay Shoots.—A small shoot of irregular form has been worked on the "hanging-wall" reef, principally above No. 1 level. The ore averaged about 1 oz. of gold per ton. The

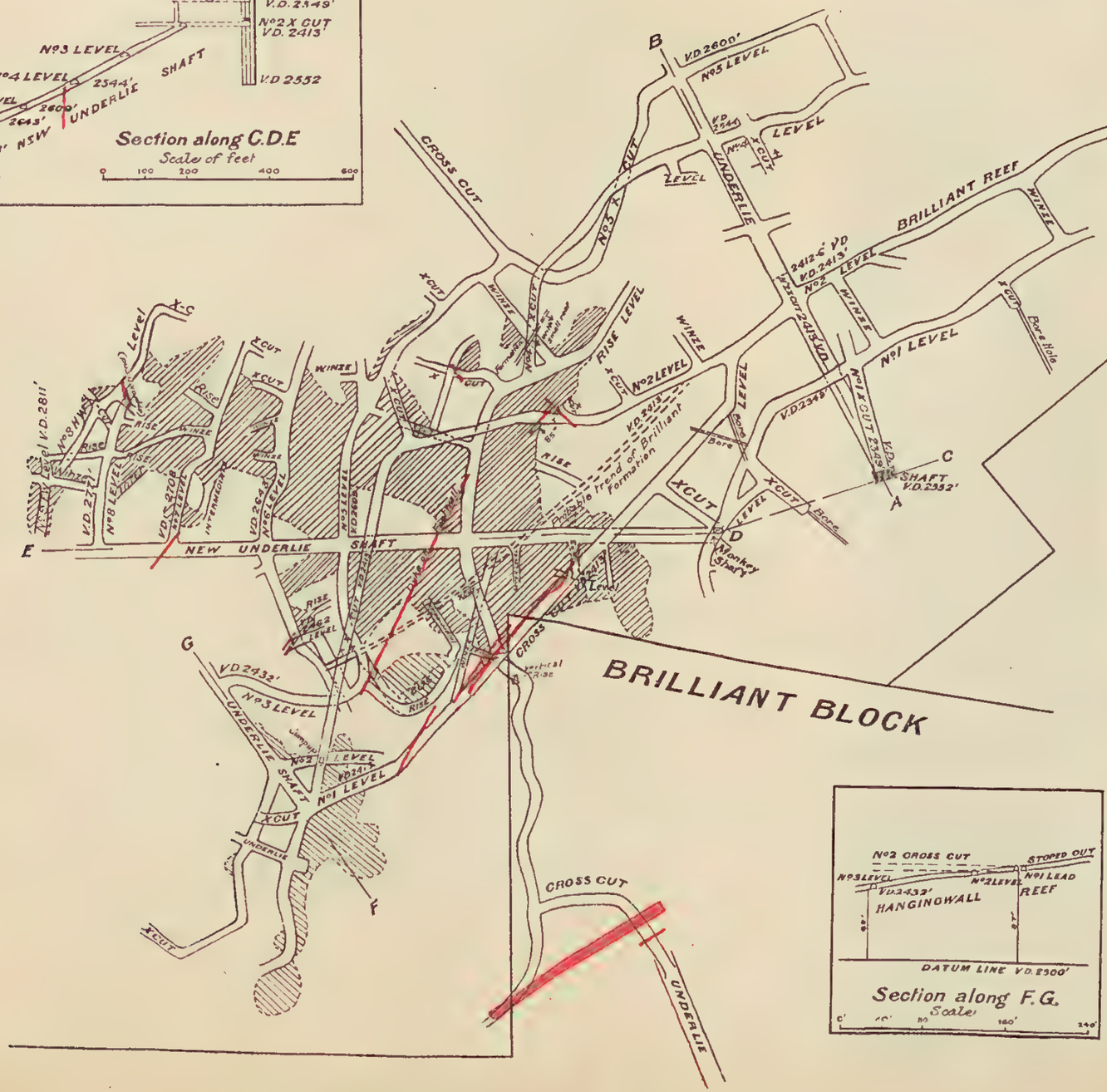
PLAN OF
UNDERGROUND WORKINGS
Taken from Mine Manager's Plan
BRILLIANT DEEPS LIMITED MINE

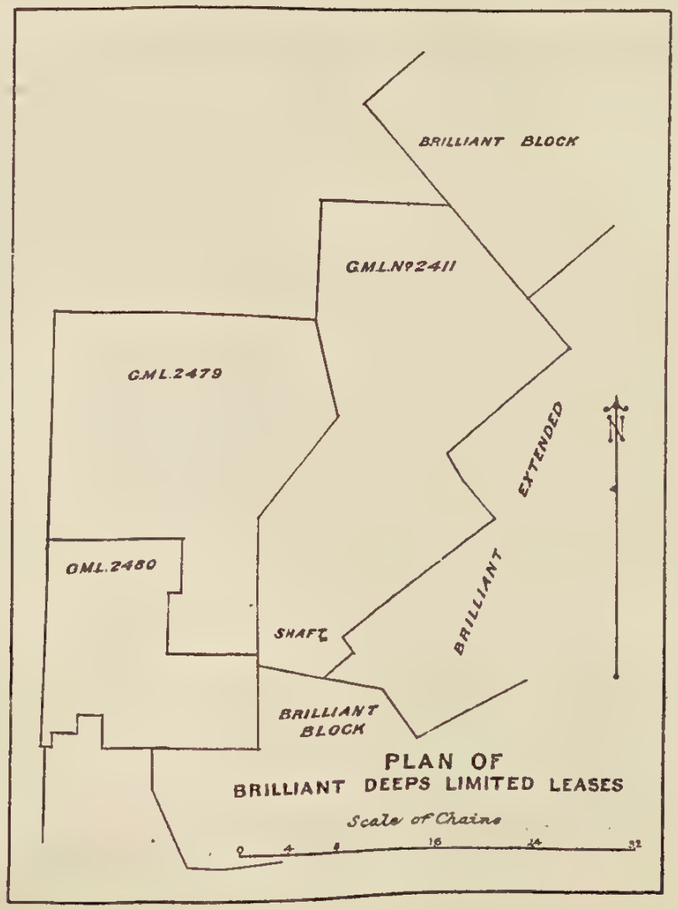
Scale of feet
0 40 80' 160 240 320

Stoping Reference
Hanging Wall Reef
Footwall Reef
N.B Practically no stoping on Brilliant Reef









"footwall" reef has furnished the largest ore shoot. It is roughly triangular shaped with the base above No. 4 level and the apex at No. 8. Its width at No. 4 is about 300 ft. and it contracts to less than 80 ft. at No. 8 level. It pitches slightly to the north in depth. There are many blanks in this shoot in the form of white unmineralised quartz bodies yielding only 3 to 4 dwt. of gold. The pay ore is heavily mineralised, chiefly carrying pyrite, but also a little galena and zinc blende. The picked ore from Nos. 4 and 5 levels yielded 1½ oz. to 2 oz. of gold per ton, but in the lower levels the average has fallen to 15 dwt. The heavily mineralised ore distributed through the poorer quartz gives much higher assay results and free gold is occasionally noticed. Below No. 7 level the main reef is impoverished, but two branch reefs on the hanging-wall between No. 7 and No. 9 levels carry payable ore. Notwithstanding the blanks in the ore it would have been possible to continue operations but for the fact that below No. 7 level there is no singly defined lode. At that point it breaks up into branches, three at least in number, each of which carry pay ore in small shoots distributed irregularly through masses of crushed and pyritous rock. It appears economically impossible to work these individually owing to the great amount of development work to reach isolated patches of ore.

Geological Features.—The country rock throughout the mine is normal grano-diorite. Both series of diorite-porphyrite dykes are in evidence in the western workings. These have been faulted by the lode fissures. The Brilliant lode at 2,600 ft. forms a well-defined fissure with a reef sometimes attaining a thickness of 6 ft. It is noticeable that almost the only sulphide present is pyrite and that the gold content is low. Where galena has occasionally been present the ore improved in value. To the west of the shaft the quartz reef gradually died out and a belt of crushed grano-diorite, seen in the crosscut from end of No. 2 level, indicates the continuation of the fissure. In this area the subsidiary fissures contain quartz reefs. In these the ore is heavily splashed with pyrite, galena and zinc blende, and they furnished the only payable ore in the mine. These show a tendency to split as in No. 8 level east ("footwall" workings) where the face at 160 ft. from the shaft showed a section of 10 ft. of bands of mineralised quartz with altered grano-diorite running through it and forming the bulk of the section, and two distinct walls diverging at an acute angle. Between Nos. 7 and 8 levels the reef has branched, the footwall reef containing very little quartz, while the hanging-wall carries quartz up to 6 ft. in thickness. In the recent workings at No. 9 level (v.d. 2,811 ft.)

another hanging-wall branch reef has been exposed all along the level carrying mineralised quartz. Between No. 7 and No. 9 levels is a highly-fractured zone, evidenced by rock crushing and replacement by ore. The distribution of the sulphide minerals and, as a corollary, the gold values are extremely variable, this becoming more pronounced in depth. Large bodies of white quartz often attaining a thickness of 6 ft. have been left unstoped. There is no general percolation of underground water along the lodes. Some of the workings are perfectly dry, and what water is present comes solely from occasional major joints in the country rock which have been penetrated by the workings. There is no evidence of faulting subsequent to the formation of the lodes.

Recent Operations.—The principal work recently has been confined to sinking on the footwall reef and extending the lower levels. A winze has been sunk to No. 9 level (v.d. 2,811 ft.), 50 ft. north of the shaft, and the level was being extended south with the intention of continuing the underlie shaft and connecting them. No. 8 H.W. level has been driven 180 ft. Between Nos. 7 and 8 the "footwall reef" is variable in size, the walls bulging to a width of 7 ft. in places, so that the ore-bodies here are more or less lenticular. The ore is here disseminated in bands through mullock and has to be largely hand-sorted. At the close of 1916 the company discontinued work and the mine is now in the hands of tributers.

New Queen Central Mine.

This mine is situated on the eastern side of the Queenton group of mines and adjoins the Bonnie Dundee. The New Queen Central Gold Mining Company in 1916 held G.M.L.'s 1602, 2478, and 2483, aggregating an area of over 32 acres. The two latter leases were recently acquired and formed portions of Marshall's Queen and Queen Central Block leases respectively. The ground, originally known as the No. 5 Just-in-Time claim, was considerably prospected in the early days, both on the reef of that name and on the Queen, the latter of which outcropped in the lease, but with poor results. About 1891 a company was formed and the mine has been almost continuously worked since either by the company or tributers, but never with very great success. Two vertical shafts have been sunk and five reefs worked in the ground, viz.:—Just-in-Time, "Old" Queen Cross, "New" Queen Cross, Victory, and the Brilliant, but although adjoining mines have had rich pay shoots, very little ore extended into this ground. The best ore obtained was from the "New" Queen Cross reef and enabled the company to pay £11,250 in dividends between 1904 and 1906.

PRODUCTION.

From 1892 to 1903 inclusive, the company's returns were 7,626 tons of ore; gold, 8,157 oz.; dividends, £1,500.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1904 ..	2,234	3,519	..	..	2,250
1905 ..	4,246	5,289	..	..	6,750
1906 ..	2,469	2,415	..	..	2,250
1907 ..	1,538	1,698	505	5,891	..
1908 ..	2,601	2,548	1,290	9,478	..
1909 ..	1,577	1,758	965	6,666	..
1910 ..	710	645	418	2,432	..
1911 ..	74	135	111	567	..
1912 ..	464	1,139	347	4,148	..
1913 ..	923	1,482	536	5,479	..
1914 ..	537	427	300	1,690	..

Underground Workings.—There are two surface shafts situated on G.M.L. 1602. No. 1 shaft, situated close to the western boundary, has been sunk vertically to a depth of 1,700 ft. It cut the Just-in-Time reef at 260 ft., the "Old" Queen Cross reef at 542 ft., a reef at 897 ft., the Victory reef at 1,021 ft., the Brilliant reef at 1,319 ft., and a reef at 1,680 ft. The "Old" Queen Cross reef was worked to a depth of 740 ft. by underlie shaft and six levels driven north and south. All the ore obtained was south of the shaft except a little on Nos. 1 and 4 north levels.

The 897-ft. reef, considered a branch of the Victory, was sunk on for about 70 ft., occasionally showing payable ore. A north level was driven but the reef was unpayable.

The Victory was opened up by underlie shaft for 300 ft. but no levels were driven as prospects were discouraging. The Brilliant reef has been a disappointment in this lease for it carried a fairly large pay shoot in the Bonnie Dundee Mine adjoining. The shaft cut it at a depth of 1,319 ft. and No. 1 level was driven 360 ft. north-east. At 220 ft. from shaft a rise connects with the Queen Cross workings on this reef. Most of the ore was obtained along No. 1 level. An underlie shaft was sunk 140 ft. on the reef and two short levels put in. A little stoping was done on No. 2 level, but the reef was patchy. The ore raised averaged 1 oz. of gold per ton.

At 1,680 ft. a reef dipping east was followed for 400 ft. by underlie shaft. The narrow strip to the south of the underlie averaged 1 ft. of 1-oz. ore. To the north of shaft the ore cut out. This reef was also worked in the Queen Cross lease to the south but was unpayable there.

No. 2 shaft, situated to the east, has been sunk to a vertical depth of 1,900 ft. It cut the Just-in-Time reef at 600 ft. and the "New" Queen Cross reef at 846 ft. On the former a level was driven 200 ft. to the north and 100 ft. to the south, but it only exposed bunches of poor quartz. At 846 ft., 15 in. of mineralised quartz was intersected. A shoot of ore, being the extremity of the rich Queen Cross shoot, was worked in the vicinity of the shaft between the depth of 820 ft. and 947 ft. The shoot extended from 200 ft. north-east of the shaft to the Queen Cross boundary. It averaged about 25 dwt. of gold per ton. An underlie shaft was sunk to a depth of 947 ft. on the reef and four levels opened. No. 2 S.W. level connects with the Queen Cross workings. In the last few years the company have continued sinking the vertical shaft, at first in the hope of picking up the reef now being worked in the Bonnie Dundee Mine, but without success.

The record of this shaft below the Queen Cross reef, as supplied by the mine manager, is as follows:—

1,390 feet:—formation with leaders of quartz dipping north.
1,453 feet:—formation (18″) with 2″ vein quartz dipping north.
(frame set, no other work.)
1,614 feet:—formation (7′) with leaders of quartz dipping north.
1,689 feet:—formation (4′) with quartz vein up to 6″ thick.
1,868 feet:—formation dipping north (being developed).
1,900 feet:—bottom of shaft.

Of the abovementioned the 1,453-ft. formation approximates more nearly to the projected position of the Brilliant reef and it is most likely the easterly continuation of that fissure which has never been productive east of the Bonnie Dundee Mine.

The 1,868-ft. formation was opened up by levels east and west for short distances. Near the shaft, in the east cut, it opens to a width of 3 ft. of formation and in the west contracts to several inches. It carries up to 2 in. of white quartz without sulphides. The prospects were never promising.

During 1916 a little prospecting work was done on the 1,453-ft. formation when the west level was driven 45 ft., but it did not carry any ore except a small leader near the shaft. The mine (No. 2 shaft) was closed down in June, 1916, after a considerable period of unsuccessful prospecting work.

Geological Features.—The country rock in the workings around No. 2 shaft consists of grano-diorite. There is little of interest for the intrusive dykes of diorite-porphyrite appear to be entirely absent. A vertical break in the country striking north-west cuts across the reef a little to the east of the shaft. It consists of a belt of soft crushed rock up to 12 ft. wide, con-

taining bands of red calcite. It has not effected any noticeable movement in the reef and appears to have no relation to the deposition of gold as its strike is at right angles to the trend of the ore-shoot. The manager of the mine stated that good ore was found alongside of it. The country in the eastern portion of the lease is more disturbed and broken and there is a heavy circulation of underground water in that area. A number of small fissures dipping dominantly to the north, in agreement with the angle of dip and trend of the Brilliant lode, have been intersected in sinking on this and the adjoining leases, but the majority of them have not offered encouragement for further prospecting. From their position and attitude they probably represent subsidiary fissures caused by the movement which produced the Brilliant fissure.

Bonnie Dundee Mine.

Situation, Leases, &c.—The Bonnie Dundee Gold Mines, Ltd., hold G.M.L. 2517, area 43 acres 3 roods 8 perches, situated in the Queenton area, to the south-east of the Brilliant Extended Mine. This includes the greater portion of Marshall's Queen lease and the eastern portion of the Brilliant Central lease, both recently acquired. The mine manager is Mr. H. Dyson.

History.—This is one of the oldest Company mines on the field, operations being started in 1882. It has been, up to the present, one of the big disappointments of the field, for although

Plate 32.—Bonnie Dundee Mine.

To end of 1916: Ore raised 59,296 tons, value £265,105; dividends £34,685.

the mines adjoining on the west have had large and payable outputs this mine has not come up to expectations. The ground was first held as Nos. 3, 4, and 5 Queen claims, for the Queen reef outcropped in the southern portion of the lease. There are several old shafts on this reef but the claims are reported to have yielded very little gold. The Bonnie Dundee Company was formed in 1883 and obtained fairly good crushings for the three subsequent years, the mine in 1886 being sold to an English Company. An underlie shaft was sunk for 1,100 ft. on the Queen lode but the deeper ground below 600 ft. was unpayable. A vertical shaft (No. 2) sunk to cut the St. Patrick reef did not reveal any payable ore, and in 1893 the No. 3 vertical shaft was started in the south-east corner of the lease. The "Old" Queen Cross, Victory, and the Brilliant reefs have been subsequently worked from this shaft. From 1908 to 1911 the mine showed good returns having opened up a pay shoot on the Brilliant lode to the east of the shaft which enabled the Company to pay £21,000 in dividends. For several years prospecting was continued on the Brilliant lode until early in 1915 a new reef was cut in a footwall crosscut from the Brilliant workings. The Company is now working on this reef which has recently yielded payable crushings.

PRODUCTION.

From 1881 to 1907 the returns were 42,337 tons of ore, yielding 49,997 oz. gold. Dividends, £7,200.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1908 ..	2,850	3,480	2,715	14,321	6,000
1909 ..	8,048	9,765	7,063	40,169	15,000
1910 ..	1,441	1,112	770	4,697	..
1911 ..	2,126	3,127	895	11,162	..
1912 ..	603	559	459	2,249	..
1913 ..	56	31	10	107	..
1914 ..	..	..	..	..	..
1915 ..	1,032	1,312	1,005	5,479	..
1916 ..	3,830	4,644	4,359	20,198	..

Underground Workings.—No. 1 shaft follows the Queen lode to a depth of 800 ft. Ten levels were opened out on the reef. No. 6 east (the longest) was driven to the boundary, a distance of 530 ft. Several of the west levels run to the Brilliant Central boundary. This shaft cut the Just-in-Time reef dipping east at 210 ft. from the surface.

The No. 2 shaft, sunk in the north-west corner of the lease, is now used by the Brilliant Extended Mine, to whose workings

BONNIE DUNDEE GOLD MINE

Plan of underground Workings

on Brilliant lode and footwall reef (present workings)

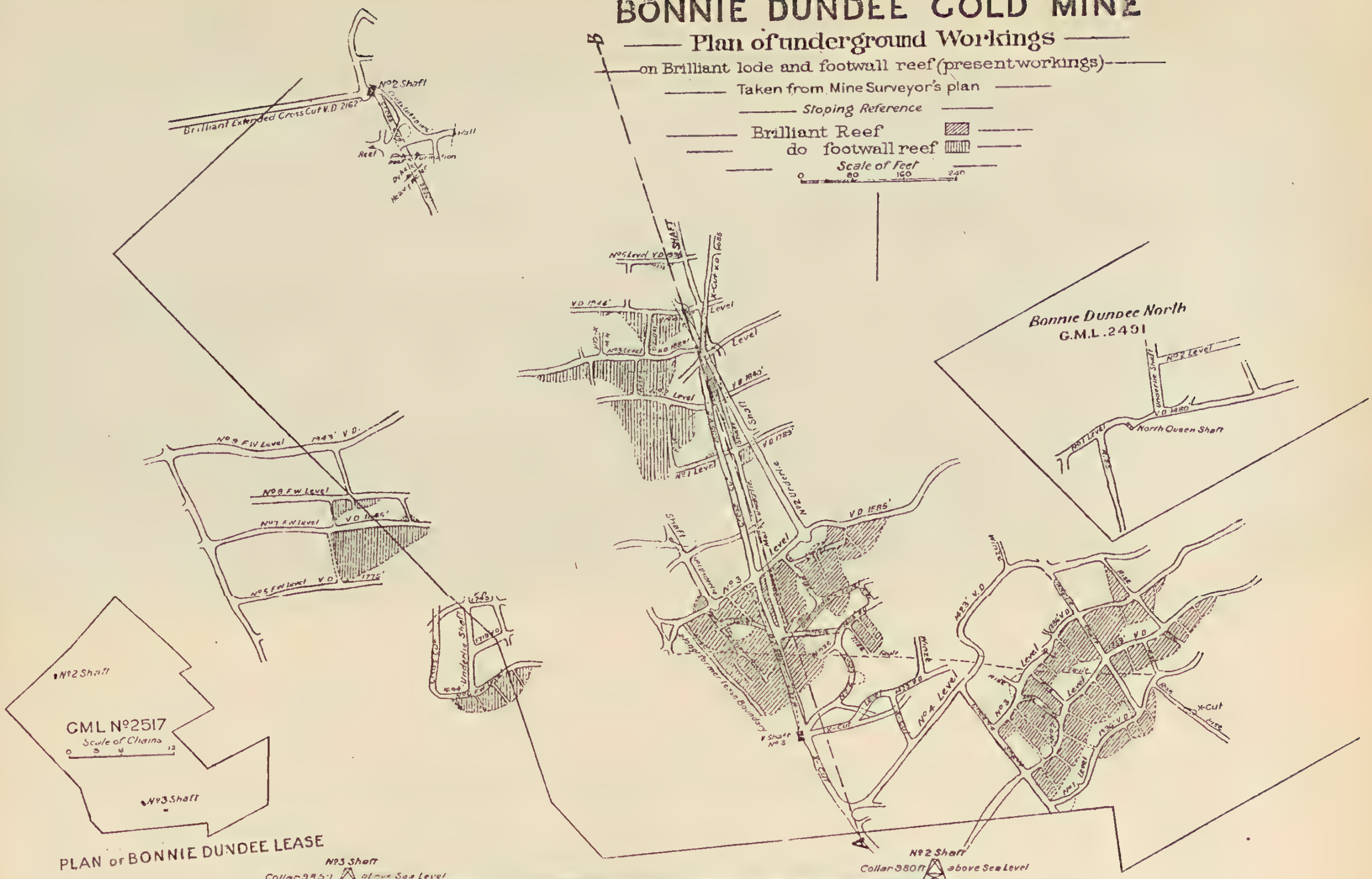
Taken from Mine Surveyor's plan

Stoping Reference

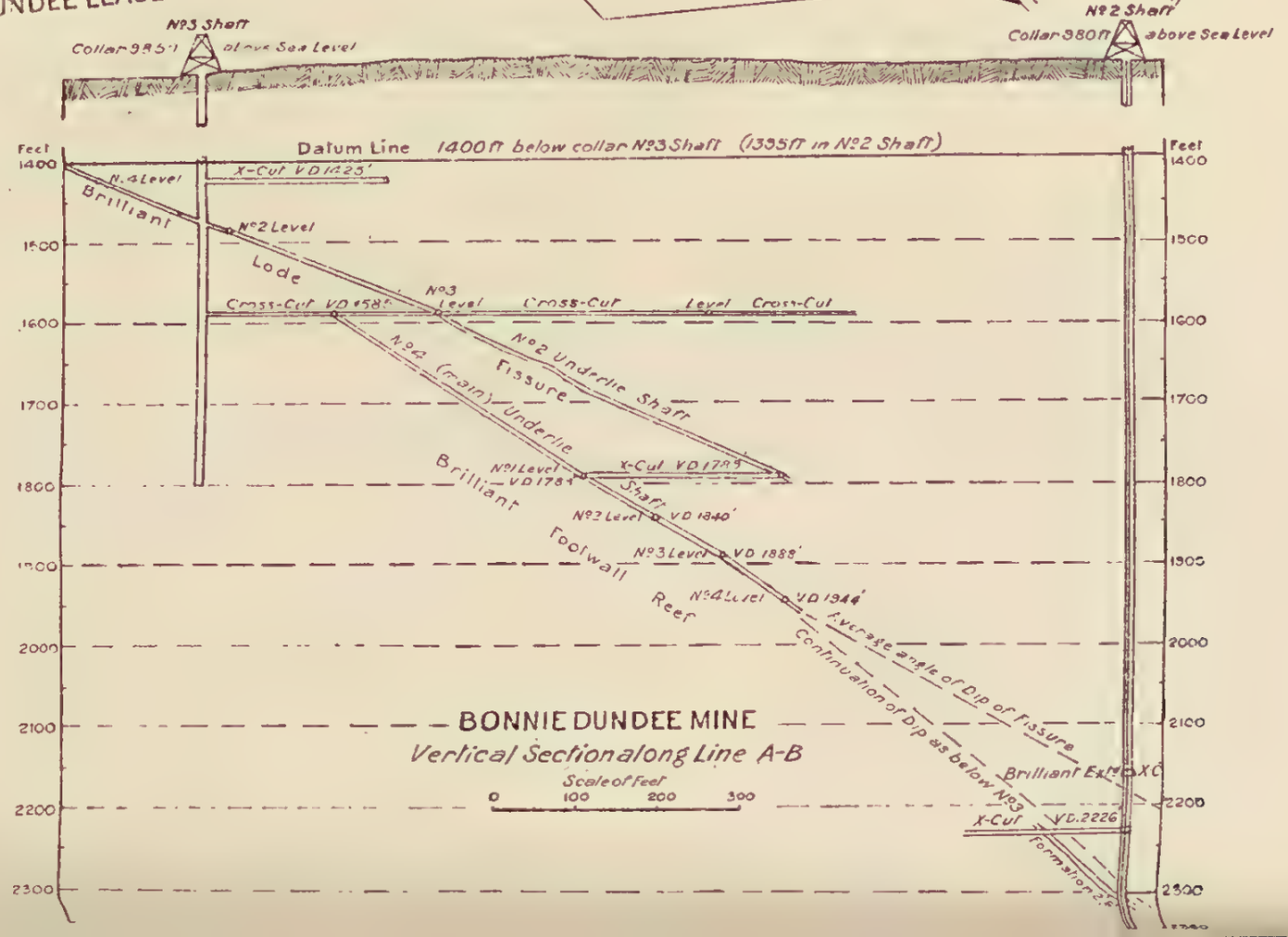
Brilliant Reef

do footwall reef

Scale of Feet 0 80 160 240



PLAN of BONNIE DUNDEE LEASE



Plan 10.

it is connected by a crosscut at a depth of 2,162 ft. The shaft, sunk to a depth of 2,300 ft., is entirely in grano-diorite and the record is as follows:—

Depth 832 feet—15 feet "formation" with 6″ quartz dipping 20° W. of N.
Depth 870 feet—15 feet "formation" with quartz veins dipping north.
Depth 1,888 feet—"formation" with 6″ quartz dipping north.
Depth 1,989 feet—6″ of quartz dipping east.
Depth 2,010 feet—vein of quartz dipping east at 40°.

A crosscut at a depth of 2,231 ft. was driven south but at a distance of 117 ft. a flow of water was intersected and this flooded the shaft, the water rising 700 ft.

The present working shaft (No. 2) is situated in the south-west corner of lease. It is down to a depth of about 1,800 ft. It cut the following reefs—Queen (286 ft.), "Old" Queen Cross (610 ft.), Victory (1,090 ft.), Brilliant (1,532 ft.). At a depth of 1,575 ft. it exposed 16 in. of quartz dipping east.

The "Old" Queen Cross reef dipping north-easterly was followed by a shaft to a depth of 727 ft. It was stoped out above No. 2 level back to the boundary. No. 4 and 5 north-west levels have been driven 200 and 90 ft. respectively. The corresponding levels on the south-east side are in only a few feet. The Victory reef, dipping east, was worked to a depth of 1,180 ft. No. 1 level extends from Marshall's Queen boundary 700 ft. north of the shaft. For 200 ft. north of the shaft the reef has been stoped along this level. As the reef was followed down it became poor, and on No. 2 level very little work has been done. From No. 2 level a crosscut was driven east 180 ft. to cut a reef intersected at 1,050 ft. in the shaft. Three short levels were driven north on this reef and a little stoping done.

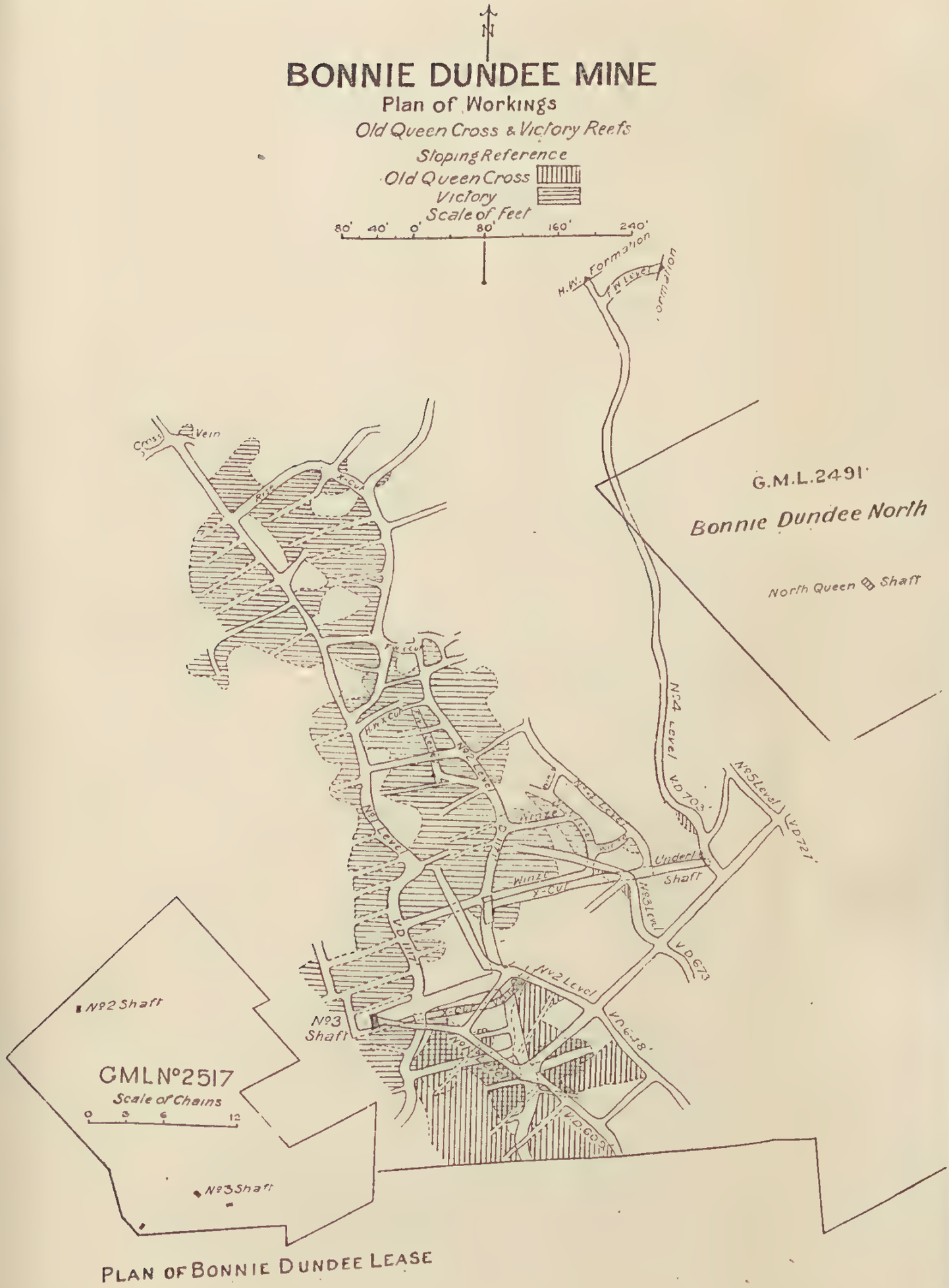
The Brilliant workings in the south part of the lease, where the biggest pay shoot was worked, are connected to the main shaft by a crosscut 130 ft. long which strikes the reef at No. 4 level. An underlie shaft runs from the New Queen Central boundary to No. 4 level, and the reef has been worked here for a lateral distance of 700 ft. Below No. 4 the reef was poor and was not worked. It was again picked up north of the shaft in the 1,585-ft. crosscut, 255 ft. from the shaft. A level at this point was driven on the reef 360 ft. north-east and 140 ft. south-west to the boundary. Considerable stoping was done along this level. From the end of the crosscut an underlie shaft follows the lode to a depth of 1,789 ft., but it was not worked.

Operations are at present confined to a footwall reef lying below the main Brilliant fissure. At No. 1 level (v.d. 1,789 ft.) the footwall reef is 120 ft. vertically below the Brilliant fissure

and 245 ft. to the south of it at that level. The reef, as far as the present workings show, strikes in a direction 78 degrees east of north and dips at an average angle of 32 degrees in a direction 12 degrees west of north. The workings are connected to the No. 3 vertical shaft by a northerly crosscut (the 1,585ft.), and at a distance of 160 ft. from the shaft an underlie shaft has been sunk to a depth of over 2,000 ft. and is being continued. Six levels have been driven on both sides of the shaft, and stoping is still in progress between No. 2 and No. 4 west levels, where the best ore was found. The reef has been followed 300 ft. west of the underlie shaft (No. 3 level), but very little work has been done on the east side as the reef is small there. Three feet is the maximum thickness of the reef, but the average is very much less.

Geological Features.—A vertical fault of inconsiderable movement has displaced all the reefs to the east of the vertical shaft. In the southern portion of the lease its strike is north-north-west, but it gradually trends to the west and passes into Marshall's Queen about 220 ft. north of the No. 3 shaft. It cuts the Brilliant reef (1,423 ft. "formation") 200 ft. east of the underlie shaft at No. 2 level, and 140 ft. east at No. 3 level. At No. 2 level the reef has been thrown up on the east side about 3 ft. At No. 4 level the upthrow is 10 ft., and on Marshall's Queen boundary it is estimated at 20 ft. It has also faulted the reefs lying above. In the Victory reef the payable ore was mostly obtained close to the fault between Nos. 1 and 2 north levels. On the Brilliant reef the only payable ore was found on both sides of this fault, but it was noticeable that the ore shoot did not follow continuously the course of the fault. The slight enrichment of the Victory reef close to the same fault leads to the conclusion that the fault fissure has influenced the deposition of gold and sulphides in this mine, and while there are several instances on the field where pay shoots are associated with small fissures, notably in the Caledonia, Clark's Worcester, and Clark's Gold Mines, the presence of faulting in relation to the largest ore shoots of the Day Dawn and Brilliant lodes is not definitely known. In this mine the "Old" Queen Cross reef has not been opened up where the fault intersects it above the Brilliant pay shoot, and from the foregoing evidence it is likely that some enrichment of the reef has occurred there similar to that in Clark's Worcester Mine, where four reefs were only payable, vertically over one another, in proximity to several small faults.

The country rock is grano-diorite apparently free of any intrusive dykes.


N
BONNIE DUNDEE MINE
Plan of Workings
Old Queen Cross & Victory Reefs
Stoping Reference
Old Queen Cross
Victory
Scale of Feet
80' 40' 0' 80' 160' 240'
H.W. Formation
IV Level
Cross Vein
G.M.L.2491
Bonnie Dundee North
North Queen Shaft
No.4 Level V.D 703'
No.5 Level V.D 721'
Winze
Under Shaft
No.3 Level V.D 673'
No.2 Level V.D 648'
No.3 Shaft
No.2 Shaft
GML No.2517
Scale of Chains
0 3 6 12
No.3 Shaft
PLAN OF BONNIE DUNDEE LEASE

Victory Mine.

Situation, Leases, &c.—The mine is situated a few hundred yards to the south of the Railway Station, and lies immediately to the south and east of the Brilliant P.C. Mine. The Victory G.M. Co., Ltd., leases are G.M.Ls. 1744 and 1745, each containing an area of 25 acres. The mine manager is Mr. P. Titley.

History and Production.—The area was taken up as a claim about the year 1875 by Messrs. E. Williams, W. Gough, and party. They worked the Victory reef until 1881, when the Victory G.M. Company was formed. The mine was purchased for £8,500, but the reef was so rich that this amount was returned from crushings within the first four months. The first crushing enabled the company to pay £5,000 in dividends. This mine holds the record for the longest working period on the field, having been continuously working for forty years. It has had varying success in working the many reefs within its boundaries, but the zenith of its success was attained when it was proved that the richest portion of the large Brilliant shoot extended into the lease on the north-western boundary. It took less than three years to work it out, but in two years £177,500 in dividends were paid from this shoot. Up to 1890 the company worked the Victory reef from the outcrop to the east boundary with regular and rich crushings. In 1889 the Brilliant reef had been found in the adjoining lease, and in 1891 the company put down their No. 2 shaft to find it. They only got a fringe of the ore shoot, but the reef was large and rich, and from 1892 to 1894

Production.

Period.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Dividends.
	Tons.	Crude oz.	£	£
1881-1889	18,842	47,616	..	63,425
1890	3,954	7,894	..	7,500
1891	3,117	5,054	..	2,500
1892	8,738	37,225	..	97,500
1893	13,826	37,766	..	80,000
1894	8,023	7,616	..	5,000
1895	2,394	1,618	..	..
1896	1,142	1,456	..	..
1897	2,408	9,701	..	15,000
1898	2,876	7,987	..	20,000
1899	3,070	7,008	..	5,000
1900-1916	29,358	41,242	18,984	10,000

it returned about 80,000 oz. of gold, forming about one-third of the total output of the mine over a period of nearly forty years. After a lapse of several lean years the company worked the Victoria shoot from the No. 3 shaft from 1897 to 1899, this yielding

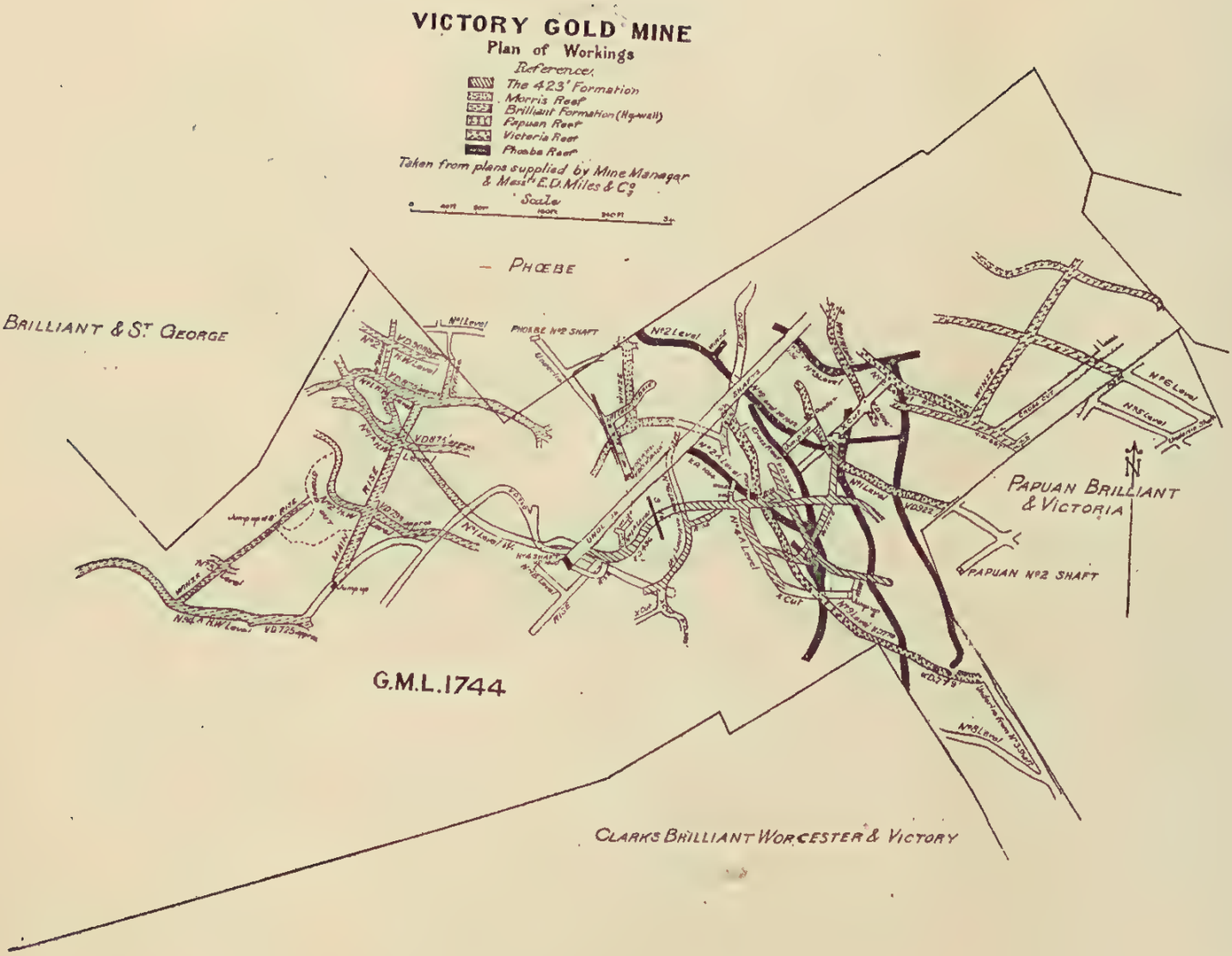
£40,000 in dividends. Since 1900 no new developments of any importance have occurred, the mine being a small but regular producer. A vertical shaft (No. 4) has been sunk to a depth of 1,050 ft. A section of the Brilliant reef was further worked in the north-east portion of the lease in addition to several small reefs, but without conspicuous success. Recently the company was working on the 423-ft. "formation" and "Morris' reefs," but though rich they are small veins and offer no prospect of a future for this old mine. The following are the complete company returns. Prior to the year 1881 the claimholders were reported to have won about 3,000 oz. of gold from the Victory reef.

Underground Workings.—There are four surface shafts on the leases. No. 1 is vertical to a depth of 116 ft., when it cuts the Victory reef. An underlie shaft has been sunk on the reef to the eastern boundary, the depth there being 686 ft. Twelve levels were driven north and south, and practically all the reef has been worked out. The reef ranged up to 2½ ft. in thickness. A footwall reef was worked between No. 5 and 9 levels, crosscuts connecting to the Victory reef workings at Nos. 6, 7, and 8 levels.

No. 2 shaft is situated about 16 chains south-east of No. 1 shaft. It was sunk vertically to a depth of 500 ft. The Brilliant fissure was cut at 320 ft. A shaft was sunk on it to the boundary of the Brilliant P.C. Mine, where it was diverted to the east along the boundary and the reef worked to a depth of 830 ft. There are seven east levels. No. 3 level was driven west 400 ft., the last 150 ft. being on a barren fissure.

No. 3 vertical shaft, in the south part of G.M.L. 1744, cut the Brilliant (Victoria) reef at a depth of 335 ft. The Brilliant reef here dips to the north-east, and the underlie shaft follows this direction to the Papuan boundary, when it turns obliquely to the north. There was only a narrow strip of ground 100 ft. wide here owing to the peculiar shape of the lease, but it was all worked out between No. 3 and No. 9 levels. Below No. 9 the reef was worked from the Papuan No. 2 shaft, No. 1 level being extended nearly 300 ft. into the Victory ground (v.d. 922 ft.).

No. 4 is the present working shaft, depth 1,050 ft. At 423 ft. a vein is now being worked to the east of the shaft. From a depth of 423 ft. an underlie shaft has been sunk on this "formation" to a depth of 710 ft. without any payable ore showing. From No. 2 level (v.d. 580) a west crosscut picked up Morris's reef dipping to the north, which has been opened up down to the Phoebe boundary. A short level exposed 9 in. of rich ore on the boundary line at a depth of 610 ft. Little


VICTORY GOLD MINE
Plan of Workings
References
The 423' Formation
Morris Reef
Brilliant Formation (Hgwall)
Papuan Reef
Victoria Reef
Phoebe Reef
Taken from plans supplied by Mine Manager & Messrs E.O. Miles & Co
Scale
PHŒBE
BRILLIANT & ST GEORGE
PAPUAN BRILLIANT & VICTORIA
PAPUAN No2 SHAFT
G.M.L.1744
CLARKS BRILLIANT WORCESTER & VICTORY

VICTORY GOLD MINE

Plan of Workings

Taken from Mine Manager's Plans

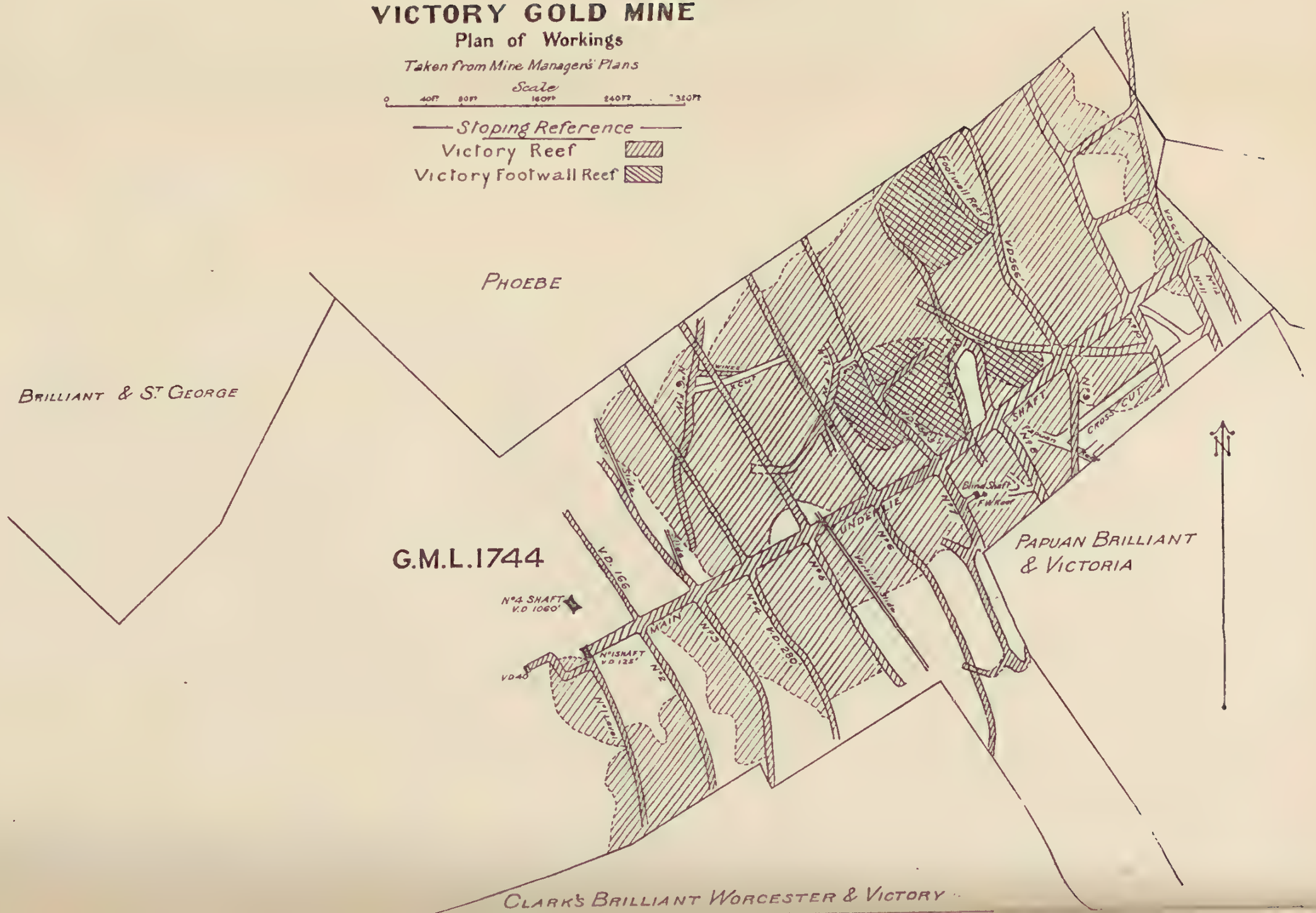
Scale

0 40ft 80ft 160ft 240ft 320ft

Stoping Reference

Victory Reef

Victory Footwall Reef



work has been done on this reef, but stoping was recently being carried on above 610-ft. level. At 725 ft. in the vertical shaft a crosscut connects with the Brilliant hanging-wall workings about 400 ft. west. This was worked between the 725 ft. and 908-ft. levels. Only one small block of ore was stoped here. The No. 3 underlie shaft leaves the vertical at 878 ft., and follows the Phoebe reef dipping east to a depth of 1,136 ft. on a small and unpayable reef. This was opened on from the north to south boundaries by several levels between 1,000 and 1,136 ft. deep, but without success. (*See* Plan No. 12.)

Geological Features.—The country rock is grano-diorite. In the eastern portion of the lease igneous dykes appear to be entirely absent. On the western workings (Brilliant reef) several diorite-porphyrite dykes were encountered, and the surface survey shows several groups of both series to be present there. There are several small outcrops of aplitic granite in that area also. An approximately vertical fault ("slide") was seen in the 423-ft. workings, 120 ft. east of the vertical shaft. It strikes 15° west of north, and is featured as a strip of crushed rock about 2 ft. wide showing no perceptible movement in the quartz vein. It was also picked up on the Morris' workings at a depth of 580 ft. In the case of the reefs worked in this mine lying one above the other, it is noticeable that the shallowest—the Victory—was the richest, the ore stoped averaging about 2 oz. of gold per ton, while all the reefs lying immediately beneath have been notably poor.

Queen Tribute Mine (formerly New Queen).

This mine is situated centrally in the Queenton group of mines, and just to the east of the Charters Towers railway station. It is held under G.M.L. 509 in the name of A. L. Wilson, and was, up to the year 1916, worked by the Queen Tribute G.M. Company under agreement with the lessee. The lease has an area of 10 acres 3 roods 5 perches.

History and Production.—It is in this ground that the Queen reef was first discovered, in the year 1872, by Messrs. Little and Marshall. The lease has been worked almost continuously from 1873 to 1916. It includes the original claims known as Queen P.C. and Queen Nos. 1, 2, and 3, under which the ground was worked until 1883. The Queen and the "Old" Queen Cross reefs were worked during that period, the latter supplying the bulk of the ore. The claim's returns are not complete, but it is estimated that nearly 40,000 oz. of gold were won from the two reefs up to the year 1883, most of which came from the No. 2 Queen and Queen P.C. claims. From 1884 the returns are complete, as will be seen from the list attached.

Up to 1887 the lease was worked by the Queen No. 2 S.W. G.M. Company with payable results, when it was sold to an English company, the No. 2 Queen G.M. Co. In 1890 it was purchased by the New Queen G.M. Co. This company exploited the deeper ground, and worked the Victory, Brilliant, and several other small reefs with payable results. Up to 1896 the mine was prosperous, chiefly owing to the returns from the Victory reef. The Brilliant reef (No. 5 formation) was comparatively disappointing, and large blocks of ore were left unstoped. Six other reefs have been opened up, but most of the returns were disappointing. There were no returns from 1908 to 1912, and in the following year the mine was sold and was worked by the Queen Tribute Company up to 1916. The last work done was confined to driving a level and sinking a winze on a small vein on the hanging-wall of the "Old" Queen Cross reef at a depth of 280 ft. The vein was too narrow (averaging about 4 in.) to be profitably worked.

The following are the complete returns from 1884 to date:—

Year.	Ore Raised.	Gold.	Year.	Ore Raised.	Gold.
	Tons.	Crude oz.		Tons.	Crude oz.
1884 ..	4,992	10,072	1896 ..	3,826	3,430
1885 ..	3,842	5,991	1897 ..	1,009	686
1886 ..	1,865	2,884	1898 ..	6,765	4,464
1887 ..	665	1,061	1899 ..	9,221	7,507
1888 ..	497	371	1900 ..	3,997	3,041
1889 ..	841	818	1901 ..	5,540	10,779
1890 ..	4,813	6,978	1902 ..	2,074	1,647
1891 ..	8,283	11,064	1903 ..	2,941	2,787
1892 ..	9,534	10,933	1904 ..	10,554	9,716
1893 ..	6,261	11,182	1905 ..	7,233	7,056
1894 ..	7,759	10,446	1906 ..	7,438	5,555
1895 ..	6,330	12,124	1907 ..	1,947	1,793

1884–1907—Dividends, £57,717.

Queen Tribute G.M. Co.'s returns—1913-1916: 666 tons of ore raised, total value £2,719.

Underground Workings.—The Queen reef and the "Old" Queen Cross reef were worked to depths of approximately 200- and 500 ft. respectively in the northern half of the lease. The lower workings are all connected to a vertical shaft sunk near the centre of the lease to a depth of over 1,700 ft. This shaft cut the Victory reef at a depth of 705 ft., the No. 2 "formation" at 812 ft., the No. 3 "formation" at 934 ft., No. 4 "formation" at 1,000 ft., No. 5 "formation" (Brilliant) at 1,276 ft., No. 6 "formation" at 1,383 ft., and No. 7 "formation" at 1,457 ft. The Victory reef has been worked out except in the north-east corner of the lease.

NEW QUEEN GOLD MINE (NOW QUEEN TRIBUT

PLAN OF WORKINGS
ON Nº 5 (BRILLIANT) & Nº 6 FORMATIONS

Taken from plans supplied by Messrs E.D. Miles and Co.

Scale
1 20 40 80 120 160 Feet

N

Reference

- Workings on Nº 5 Formation (Brilliant)
- Stoping " " " "
- Workings on Nº 6 Formation H & F Walls
- Stoping on Nº 6 Hangingwall Reef
- Stoping on Nº 6 Footwall Reef

BRILLIANT

CENTRAL

MARSHALL'S

QUEEN

KELLYS
QUEEN
BLOCK

VICTORY

BAND OF HOPE

XCUT V.D. 1380'

Considerable stoping done on

Hanging & Footwall Reefs

Vertical Shaft

Nº 7 F.W. LEVEL

Nº 6 F.W. LEVEL V.D. 1457

Nº 5 LEVEL V.D. 1363

Nº 4 LEVEL V.D. 1328

Nº 3 LEVEL V.D. 1305

Nº 2 LEVEL V.D. 1276

Nº 1 LEVEL

Nº 1 B LEVEL V.D. 1485

Nº 1 S LEVEL

Nº 3 UNDERLIE

Nº 2 S LEVEL

Stoped

UNDERLIE V.D. 1509'

Nº 1 LEVEL

V.D. 1518

SHAFT V.D. 1223'

RISE LEVEL

No. 2 "formation" carried a small reef dipping north-west. It has been worked from the Band of Hope boundary to a depth of 836 ft.

No. 2A "formation" was intersected by a 50-ft. crosscut from the shaft at a depth of 860 ft. It was opened up to a depth of 926 ft.

No. 3 "formation" was opened up by levels for 180 ft., but no payable ore was found. No. 4 "formation" was cut at 40 ft. from the shaft at a depth of 1,002 ft. It was opened up to a depth of 1,146 ft. An underlie shaft was sunk and five levels driven. No. 3 N.W. level was put in 300 ft. A little stoping was done on the north side of the shaft. No. 5 "formation" (Brilliant lode) has been worked over the eastern half of the lease. West of the shaft the reef proved unpayable. No. 2 level runs east from the shaft almost to the boundary. Two underlie shafts have been sunk from this level at distances of 60- and 280 ft., respectively, east of shaft. The latter runs down to the Brilliant Central boundary, the depth there being 1,520 ft. The lode above No. 2 level is connected to the main shaft by a crosscut at a depth of 1,223 ft. (No. 1 level). The workings extend above No. 1 to the Band of Hope boundary. Most of the ore came from above No. 3 level (v.d. 1,305 ft.), and the reef is almost all stoped out back to the boundary. Below No. 3 level most of the ore has come from No. 6 level, and a little stoping has been done down to No. 8. To the west of the vertical shaft there is an area of 250 ft. by 500 ft. not opened up on this lode. Along the western underlie shaft the reef averages a thickness of 18 in. of slightly mineralised quartz, from which trial crushings are reported to have averaged 8 dwt. of gold. No. 6 "formation," dipping easterly, carried a reef containing patches of payable ore from the shaft down to Marshall's Queen boundary. An underlie has been sunk to that boundary at No. 5 level (v.d. 1,530 ft.) from the No. 1 level (v.d. 1,383 ft.). The reef has been followed by No. 3 level for 500 ft. No work has been done to the west of the main shaft. No. 7 "formation," cut at a depth of 1,457 ft., carried a small quartz vein. It has recently been worked by the Tribute Company without success. *(See Plan No.* 14 *for workings on Brilliant and No.* 6 *" formations").*

Geological Features.—The grano-diorite forming the country rock appears to be entirely free of any igneous intrusives. A complex system of mostly small fissures is present, of which two groups may be distinguished, one dipping easterly and the other northerly. On the reefs below the Victory reef the pay

ore has always been confined to the east of the main shaft, but there is no change of country rock, nor any geological data on which to found a definite theory as to why conditions for enrichment were specially favourable in that area.

Brilliant (P.C.) Mine.

The Brilliant Mine (usually called the Brilliant P.C.), which closed down several years ago, has been one of the big producers of the field, the output of gold only being exceeded by three other mines on the field. The total returns were 340,582 tons ore, 403,198 oz. gold, residues valued at £5,242, dividends £680,416. The lease of 25 acres (G.M.L. 585) was taken up by Richard Craven in the year 1886, on a hitherto unproductive portion of the field. The Brilliant Gold Mining Company was formed, and in sinking a shaft they had the good fortune to cut, at a depth of 765 ft., the most productive ore shoot worked on the field. To this enterprise must be credited the resulting deep sinking boom in 1890 along the Brilliant lode, which has resulted in payable ore being found to a depth of nearly 3,000 ft., and led to the discovery of other reefs which, with the Brilliant, have contributed more than half of the gold yield of the field. The mine, which is situated on the eastern boundary of the city area, had a wonderfully successful career for a period of thirteen years

Production.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1889	3,620	9,175	..
1890	10,908	26,559	50,000
1891	21,328	36,605	75,000
1892	22,905	24,221	37,500
1893	22,350	23,000	18,750
1894	32,725	33,347	43,166
1895	33,772	35,058	55,250
1896	32,263	34,182	58,500
1897	32,770	40,338	80,166
1898	33,057	37,404	81,250
1899	30,185	31,265	56,333
1900	23,405	26,243	39,000
1901	13,927	16,222	32,500
1902	10,489	12,334	22,750
1903	6,887	6,754	3,250
1904	3,179	2,659	..

The returns (mostly from tributes) for the period 1905 to 1916 were—5,812 tons of ore, gold 6,240 oz., value of residues £5,242. Total value of ore, £25,816. Dividends, nil.

—from 1890 to 1902. In 1903 the ore shoot was practically worked out and since that date operations have largely been devoted to prospecting for the eastern extension of the Day Dawn

lode. In 1904 the underground workings of the mine caught fire and burnt for several days, causing a number of fatalities. Up to 1912 prospecting work was carried on but without success, and in 1914 the company ceased operations. Small parties of tributers are still carrying on in the old workings.

Underground Workings.—The vertical shaft has been sunk to a depth of nearly 1,800 ft. The Brilliant lode was intersected at 765 ft. Practically the whole of the area has been stoped out on the lode except a narrow strip along the western boundary. Several small but payable branches of the main reef have been worked. The main underlie shaft follows the lode to a depth of 1,450 ft. on the Brilliant and St. George boundary. The levels have been driven the full extent of the lease and are connected to the Brilliant and St. George, the Brilliant Block, and the East Mexican workings. Practically no area remains unexplored on the lode. The vertical shaft was sunk in recent years to intersect the continuation of the Day Dawn lode. A fissure was cut at a depth of 1,435 ft., and a level driven west 300 ft. The No. 2 level on the Day Dawn lode in the New Brilliant Freeholds was driven 360 ft. east into this mine. A north crosscut at a depth of 1,596 ft. from the vertical shaft cut the fissure again and this followed west connected with No. 2 level from the New Brilliant Freeholds. This proved that the fissure was a continuation of the Day Dawn lode, but it did not carry any payable ore. The lode was opened up by underlie shaft and levels in the western ground of the lease to a depth of 1,755 ft., but no payable ore was found and no further work has since been done.

Brilliant and St. George Mine.

The gold yield of this mine has only been exceeded by the Day Dawn Block and Wyndham and Mills United mines on the field. It was recently closed down, but since the year 1892 it has produced 371,088 tons of quartz yielding 462,296 oz. of gold, exclusive of residues valued at £67,493, and paid £787,800 in dividends. The area included in the lease may justly be regarded as the most productive on the field, for several rich reefs were worked in early days, the returns of which are not included in the above figures. This area of 18½ acres has returned approximately £900,000 in dividends.

History.—The ground was worked from about 1880 to 1889 under three claims known as the St. George P.C., The Sovereign, and the St. George, Queen, and Victory Grand Junction. The St. George reef was worked to a depth of about 650 ft., the ore being exceedingly rich. Approximately 40,000 oz. were won on

the three claims, of which the St. George P.C. yielded nearly half. The crushings from that claim for the year 1887 averaged 6 oz. of gold. When the Brilliant reef was discovered in 1889 the St. George reef was nearly worked out and the three claims were amalgamated and the Brilliant and St. George Gold Mining Company formed to test the Brilliant lode. In the year 1891 the lode was intersected at a depth of 1,015 ft. A few months elapsed before payable stone was found in No. 1 west level. From 1892 to 1908 the mine had a wonderful record of prosperity, for practically the whole of the lease was productive on the Brilliant lode. Since 1908 the ore reserves have gradually disappeared and returns have steadily fallen. The Company in 1908 started prospecting for the Day Dawn lode by sinking the shaft below the Brilliant and driving a crosscut south from the 1,864-ft. level. No success was attained, and with the exhaustion of the Brilliant ore shoot mining operations ceased in 1914.

PRODUCTION.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1892 ..	6,339	6,731	..	..	2,400
1893 ..	9,849	11,048	..	..	10,800
1894 ..	10,656	17,599	..	..	33,000
1895 ..	17,501	29,870	..	..	57,600
1896 ..	19,987	30,030	..	..	61,200
1897 ..	20,223	31,886	..	..	63,000
1898 ..	28,658	43,652	..	..	84,600
1899 ..	34,224	41,383	..	..	95,400
1900 ..	34,949	36,857	..	..	81,000
1901 ..	31,193	27,633	..	..	55,800
1902 ..	25,669	17,781	..	..	55,800
1903 ..	28,897	21,690	..	..	52,200
1904 ..	28,350	46,641†	..	..	70,200
1905 ..	23,993	39,291†	..	..	43,200
1906 ..	19,662	31,627†	..	..	14,400
1907 ..	13,995	8,385	24,687	54,066	7,200
1908 ..	7,108	6,275	18,255	39,855	..
1909 ..	4,702	5,654	16,651	36,343	..
1910 ..	2,541	3,263	5,206	17,260	..
1911 ..	1,400	2,005	1,187	9,186	..
1912 ..	1,100	1,685	938	6,826	..
1913 ..	917	1,177	489	4,484	..
1914 ..	175	148	80	554	..

† Includes returns from treatment of accumulated tailings.

Description of Mine.—The main vertical shaft is 1,900 ft. deep. The Brilliant lode was intersected at a depth of 1,015 ft., and it has been worked out between the depths of 900 and 1,900 ft. From the vertical shaft an underlie shaft follows the lode northerly to the Brilliant Extended boundary, and levels have been driven at intervals of about 100 ft. to the lease boundaries. At a depth of 1,864 ft. a south crosscut was driven from the vertical shaft 230 ft. to the boundary of the Brilliant P.C. Within that mine it was driven south-west a further 250 ft., the object being to prove if the Day Dawn lode extended into the lease. A rich splash of ore was opened up but died away within a few feet, and that was the only indication of the lode. On the St. George reef three underlie shafts have followed the reef, the deepest being the St. George P.C., which extended easterly into the ground of Kelly's Queen Block mine to a depth of 650 ft. This reef dipping easterly outcropped along the western boundary of the lease, and to a depth of 400 ft. has been worked along a distance of about 800 ft. The ore shoot worked on the Brilliant lode forms the central part of the ore shoot worked in the Brilliant P.C. mine nearer the surface and in the Brilliant Extended mine below a depth of 1,900 ft. The shoot pitches easterly in depth, and the average stope width of shoot was about 1,000 ft. The ore from the Brilliant and St. George section of the shoot averaged 26 dwt. of gold per ton. The workings in this mine could not be inspected. It is reported that dykes of diorite-porphyrite have been met with in the mine. These dykes are present in the Brilliant Block adjoining. The underground plans do not show any evidence of noticeable dislocation in the lode by faulting.

Brilliant Block Mine.

The mine is situated on the eastern boundary of the city area, and was held under G.M.L. 2314 of 35½ acres by the Brilliant Block Gold Mining Company, Limited.

History.—The ground was first taken up in 1889 by Hon. E. H. T. Plant, M.L.C., and the Company formed to sink a shaft for the Brilliant lode. In 1891 the shaft bottomed on the Brilliant reef at a depth of 1,090 ft. The reef was 6 ft. thick, and averaged over 1 oz. of gold. From 1892 the mine had a successful career for seven years, during which the reef was worked to a depth of 1,500 ft. As the shoot ended there prospecting work was undertaken in various parts of the lease. A small shoot was worked on the Brilliant Extended boundary from 1904 to 1906, from which £7,500 were paid in dividends. When this was exhausted the vertical shaft was sunk to find the Day Dawn

lode. This was opened on at 2,000-ft. level, and a shaft sunk on the lode for 70 ft. and a level driven west 300 ft., but it was unpayable. In 1913-4 the workings were connected to the Bril-

PLATE 33.—BRILLIANT BLOCK MINE.
To end of 1916: Ore raised 158,606 tons, value £470,100; dividends, £81,250.

liant Deeps mine and the "hanging-wall" reef in that mine was opened up in the Block mine. The crushings were on the whole unpayable, and after a period of seven years' fruitless pros-

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1892	6,786	4,825	..
1893	7,919	7,882	2,500
1894	22,640	23,072	36,250
1895	30,910	26,684	27,500
1896	21,621	12,288	..
1897	18,876	12,793	5,000
1898	15,995	9,434	2,500
1899	2,274	877	..
1900	2,893	1,076	..
1901	2,566	1,268	..
1902	1,960	5,848†	..
1903	579	249	..
1904	5,819	8,897	2,500
1905	7,433	13,092	5,000
1906	8,451	4,326	..

† Includes 5,323 oz. of gold recovered from accumulated tailings.

pecting work on the Brilliant and Day Dawn lodes the Company ceased work in 1916. Several parties of tributers are still working. The mine since 1892 has yielded 158,606 tons of quartz for 133,988 oz. of gold, and paid £81,250 in dividends.

For the period 1908 to 1916 the returns were (mostly tributers) 1,884 tons of ore raised, gold 1,367 oz., value of residues £1,141; total value of ore, £5,988.

Underground Workings.—The three-chambered vertical shaft is 2,176 ft. deep. It now serves as an upcast shaft for the Brilliant Deeps workings. The Brilliant lode was cut at a depth of 1,090 ft., and it has been followed northerly by an underlie shaft to a depth of 1,750 ft. Twelve levels have been opened to the lease boundaries. No. 12 level, the lowest, is in 530 ft. to the west and 630 ft. to the east. From the end of No. 12 east an underlie shaft has been sunk on the lode to the Brilliant Extended boundary to a depth of 2,005 ft. A narrow strip of payable ore was stoped out below 1,850 ft. The 2,005 footwall level was driven west several hundred feet, but the lode was unpayable. The bulk of the stoping is confined to the lode above No. 9 level (v.d. 1,510 ft.). The vertical shaft cut the Day Dawn fissure at 1,950 ft. At 2,000 ft. a north crosscut went through the fissure at 80 ft. from the shaft. A level was driven on it westerly for 287 ft., and a shaft sunk from the crosscut for 70 ft., but the fissure was barren. At a depth of 2,150 ft. a south crosscut was driven from the shaft for 200 ft., and a diamond drill bore penetrated a further 200 ft. from the end without discovering any ore. The 2,000-ft. crosscut has been driven north-west a distance of 680 ft. and from the end an inclined shaft connects to the westerly workings of the Brilliant Deeps at No. 4 level (v.d. 2,533 ft.). From this level the Block Company recently put up a vertical rise and cut the "hanging-wall" reef of that mine at 126 ft. above. A little stoping was done here but the ore being unpayable work was stopped.

Ore Shoots.—The western portion of the main Brilliant shoot was worked in this mine. As the pitch of the shoot is to the east, most of the ore came from the lode on the eastern boundary of the lease, which was stoped to a depth of 1,600 ft. On the west boundary the pay shoot died out at 1,400 ft. A small section of the shoot extended into this mine on the Brilliant Extended boundary between 1,850 ft. and 2,000 ft. levels. On the Day Dawn lode no payable ore was found. The barren character of the fissure, however, encouraged very little prospecting work.

Geological Features.—The country rock is normal granodiorite, which is intruded by several groups of diorite-porphyrite dykes of both series. These are to be seen in the inclined shaft connecting the workings with those of the Brilliant Deeps. The Brilliant workings could not be inspected on account of their non-ventilation, having been closed up for many years.

Brilliant Central Mine.

This mine is situated in the Queenton area, several hundred yards to the north-east of the railway station. The mine, held under G.M.L. 1593, of 23½ acres, was worked from 1891 to 1915, and has been one of the most productive mines working on the Brilliant lode, yielding 225,536 oz. of gold from 242,444 tons of ore, and paying £291,466 in dividends.

History and Production.—The ground included in the Brilliant Central lease was first taken up in 1873. It became known as the Bryan O'Lynn claim and was owned by Messrs. F. Stubley, John Cooper, and H. Phillips. The Queen reef was worked in this claim to a depth of 400 ft., when it became unpayable. In 1879 it headed the annual returns on the field with 11,082 oz. of gold from 4,155 tons of ore. Between the years 1877 and 1882 a total of 24,861 oz. of gold were won and the claim paid £60,000 in dividends. The mine was worked desultorily for a number of years after that, the largest return recorded being 333 oz. for the year 1887. In 1891 the Brilliant Central Gold Mining Company was floated, and a deep shaft started, to work the Brilliant lode and prospect the deeper ground. The Victory reef, which was cut at 721 ft., was worked from 1893 to 1895 with good returns, the operations resulting in the distribution of £15,000 in dividends. The vertical shaft was then continued and cut the Brilliant footwall lode in 1898 at a depth of 1,566 ft. A crosscut put in picked up two additional reefs—the main Brilliant reef (known as the Brilliant "hanging-wall" reef in this mine) and an intermediate reef. Since then the Company has worked on these three reefs of the Brilliant lode with great success. The main shaft was further sunk to a depth of 2,000 ft., and some of the shallower veins cut in the shaft above the Brilliant lode have been opened up but without revealing further ore. The returns fell away after 1905, and tributers were working in the mine for the three years up to 1915. Early in 1915 the mine was closed down.

The following are the complete returns from 1892 to date:—

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1892 ..	63	94	..	..	..
1893 ..	1,905	2,722	..	..	1,666
1894 ..	6,808	9,810	..	..	11,250
1895 ..	2,992	2,487	..	..	2,500
1896 ..	202	258	..	..	..
1897 ..	67	123	..	..	..
1898 ..	941	440	..	..	..
1899 ..	1,734	1,884	..	..	..
1900 ..	5,637	6,775	..	..	5,000
1901 ..	19,768	25,228	..	..	45,000
1902 ..	31,130	32,602	..	..	68,750
1903 ..	38,669	35,339	..	..	55,000
1904 ..	36,606	32,867	..	..	60,000
1905 ..	30,389	19,031	..	..	27,500
1906 ..	19,656	10,392	..	..	7,500
1907 ..	14,079	8,353	12,455	41,668	5,000
1908 ..	14,250	8,475	10,041	39,623	5,000
1909 ..	7,536	4,861	5,120	21,308	..
1910 ..	2,967	2,840	3,329	13,046	..
1911 ..	4,379	5,086	2,854	20,135	..
1912 ..	3,016	2,832	1,716	11,861	..
1913 ..	1,268	1,492	1,103	6,112	..
1914 ..	1,382	1,483	1,115	6,167	..

Underground Workings.—The vertical shaft is 2,002 ft. deep. The Victory reef was cut at 721 ft. on a pay shoot which has been worked on the rise from the shaft back to Kelly's Queen Block, between the south boundary and 150 ft. north of the shaft. To the east of the shaft the ore was poorer but the reef was opened up to the eastern boundary at No. 7 level (v.d. 913 ft.). Below No. 6 level (v.d. 831 ft.) no payable ore was found. To the north the reef was tested by driving No. 4 level (v.d. 721 ft.) 800 ft. north on a poor reef, where it intersected the Queen fissure. The Queen was followed for 200 ft. east and west. The only prospect was found at 85 ft. west, where the fissure carried 6 in. of quartz. This was not tested.

The lode cut at a depth of 1,566 ft. proved to be the Brilliant footwall reef. This has been worked from two underlie shafts down to the Brilliant Extended boundary. The main Brilliant reef ("hanging-wall" reef) is connected to the vertical shaft by a north-west crosscut 340 ft. long. Down to No. 4 level this reef was worked from an underlie shaft sunk from the end of the crosscut. At No. 5 level (v.d. 1,772 ft.) another crosscut connects the main and footwall reefs and from the end of this the No. 4 underlie shaft has been sunk on the main reef

to the Brilliant Extended boundary. Most of the levels extend to the east and west boundaries, except in the north-east section of the lease.

The intermediate reef has been worked by a number of short crosscuts from the footwall workings. At depths of 1,175 ft. and 1,318 ft. two small reefs were cut. The former dips to the east and was opened up for a distance of 80 ft. by a level. The latter also dips easterly and a level was driven northerly for 250 ft. Below 1,566 ft. the shaft did not disclose any further reefs.

Geological Features.—The geological features are similar to the surrounding mines of the Queenton area. The grano-diorite country has not been intruded by igneous dykes. There have been a large number of small fissures dipping east and north but beyond those already worked they have no persistency and are often barren of quartz. The main Brilliant reef was the biggest, averaging nearly 3 ft. thick. Values have been more evenly distributed in this than the other reefs, the ore averaging 17 dwt. of gold per ton. The footwall reef carried richer ore as a rule but was more patchy. A vertical buck reef 2 ft. thick was seen in No. 4 H.W. level near the No. 5 pass, and this was again picked up in No. 6 F.W. level at 114 ft. west of No. 2 underlie shaft. It trends north-west and appears to be continuous right through the mine. It is older than the Brilliant lode, but the displacement could not be determined owing to the timbering of the walls of the level. From its comparative position, however, in the two levels mentioned, the movement was slight, probably not more than 15 ft. This is in conformity with the slight movement, indicated in other mines by the faulting of the dioritic dykes, for the formation of the Brilliant lode fissure. A fault hading east at an angle of 45 deg. cuts the main reef on No. 1 H.W. level 50 ft. east of the crosscut. The country here is much broken but this fault has been traced into the Brilliant Extended mine, where the reef has scarcely been displaced. In the Central mine, however, the reef did not extend east of this fault, as has been the case in the Extended mine. This is undoubtedly due to the ore shoot pitching east with increasing depth and the fault has no bearing on the enrichment of the lode. A small vertical fault was seen at No. 7 plat on the footwall reef. The upthrow on the east side is 9 ft. The fault fissure carries several inches of mineralised quartz, and the manager stated it also contained gold. The reef was rich on the west side of fault, but on the east side it was poorer, although payable. In this case the similarity of the ore to the filling in the fault fissure and the enrichment along its course,

suggests the latter as a channel through which the auriferous solutions were carried to the lodes. This has been noted in several other mines of the field.

Ore Shoots.—The ore shoot worked on the Victory reef was the northern fringe of the one big shoot on that reef worked from the surface in the Victory mine to a depth of 800 ft. in the New Queen and this mine. The pitch of the shoot corresponds to the direction of dip of the reef. In the Central mine the reef averaged 1 ft. in thickness, and the pay shoot carried 25 dwt. of gold per ton. The shoot worked on the Brilliant lode was the eastern section of the main Brilliant shoot, pitching to the east in depth. Followed to the east, the ore in this mine declines in value, and near the eastern boundary the reef dies out. The best ore came from the western side of the shaft, where it averaged 17 dwt. of gold, and in Kelly's Queen Block, and the Brilliant and St. George further west, at similar depths, it averaged over 25 dwt.

Kelly's Queen Block Mine.

The mine is in the Queenton group, and the Charters Towers railway station is situated on the lease, G.M.L. 1595, area 8 acres 2 roods 17 perches. It has contributed largely to the gold yield of the field, principally from the Victory and the Brilliant reefs, but a number of other smaller reefs, including the Queen and the St. George, have also been worked. There are two vertical shafts on the property. No. 1 shaft, near the south-east corner of the lease, was put down to the Victory reef, which was worked in the southern half of the lease between the depths of 450 ft. and 650 ft. From 1892 to 1895, inclusive, 9,072 tons of ore raised from this reef yielded 19,792 oz. of gold, and £40,000 in dividends were paid.

The St. George reef previously worked from the No. 2 shaft proved disappointing, very little ore being obtained. The Brilliant reef supplied the bulk of the total output from the mine, which was right on the ore shoot which extends from the Victory mine to the Brilliant Extended. The No. 2 shaft reached the lode at a depth of 1,450 ft., and the big returns from 1897 onwards were derived from this reef. In the last few years the 1,212 ft. and 1,316 ft. formations and the St. Patrick reef have been worked, also a cross reef on the Brilliant between the depths of 1,400 and 1,500 ft., the latter being opened up for 400 ft. north of the shaft, and yielding most of the ore won subsequent to the year 1910. The mine was working until 1913 and has since been closed down.

PRODUCTION.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1892 ..	574	2,605	..	..	6,000
1893 ..	3,024	6,094	..	..	15,800
1894 ..	3,862	8,090	..	..	15,800
1895 ..	1,612	3,003	..	..	2,400
1896 ..	532	892	..	..	..
1897 ..	1,641	2,263	..	..	..
1898 ..	5,043	11,240	..	..	18,000
1899 ..	14,285	19,259	..	..	54,000
1900 ..	21,087	23,666	..	..	50,400
1901 ..	10,683	11,487	..	..	19,800
1902 ..	2,909	2,846	..	..	..
1903 ..	979	643	..	..	..
1904 ..	378	303	..	..	..
1905 ..	639	679	..	..	..
1906 ..	4,886	4,522	..	..	7,200
1907 ..	7,284	5,707	9,446	29,112	7,200
1908 ..	3,130	1,962	949	7,748	..
1909 ..	2,059	1,452	859	5,840	..
1910 ..	1,061	1,031	721	4,261	..
1911 ..	2,175	3,317	1,806	13,472	3,600
1912 ..	2,588	2,212	1,972	9,606	..
1913 ..	1,155	664	1,822	4,282	..

MARSHALL'S QUEEN MINE.

Formerly G.M.L. 1927, area 7 acres 3 roods. The area is now included in G.M.L. 2478 (New Queen Central) and G.M.L. 2517 (Bonnie Dundee). It comprised the claims worked as Nos. 1 and 2 North-East Queen in the early days of the field. It was since the year 1899 that the deeper reefs on the property were worked, but prior to that the Queen reef was worked to a depth of 400 ft. from an underlie shaft, but the returns were small and unpayable. A vertical shaft was sunk to a depth exceeding 1,500 ft., and the Victory, Brilliant (hanging and footwall reefs), and the No. 6 formation have been worked, though the tonnage of ore and the returns have never been very large. Most of the work done was on the Brilliant hanging-wall reef, which has been worked from the shaft to the northern boundary of the lease between the depths of 1,480 ft. and 1,750 ft. The levels extend to the east and west boundaries and between No. 2 level (v.d. 1,541 ft.) and No. 5 level (v.d. 1,649 ft.) most of the ore has been stoped out. The footwall reef was worked in the north-western corner of the lease through a crosscut (v.d. 1,694 ft.) connecting to No. 6 H.W. level. The old plans show a small block of ore stoped out along No. 1 level.

An underlie shaft was sunk on the Victory reef from the vertical shaft to the east boundary (v.d. 1,063 ft.) and opened up by levels for a distance of 300 ft. The No. 6 formation was worked south of the main shaft. It dips easterly and an underlie shaft was sunk from the west boundary on No. 1 level (v.d. 1,494 ft.) to the former boundary of the New Queen Central mine (v.d. 1,610 ft.). Four levels were put in following the reef northerly as far as the main shaft. The workings are connected to that shaft through the No. 1 level on the Brilliant. The mine closed down in 1913.

PRODUCTION.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1892-1906 ..	24,991	22,680	..	..	7,200
1907-1913 ..	21,785	17,433	12,147	70,689	2,400

PHOEBE MINE.

This mine, centrally situated in the Queenton area and close to the railway station, has a disappointing record, for it is surrounded by mines which have all been prominent contributors to the gold yield of the field. Unfortunately for the Company the mine, which embraced an area of only 6 acres, lay in a comparatively poor zone between the two biggest shoots of the Brilliant lode. The ground has been worked from the year 1874. In those days it included No. 5 and No. 6 S.W. Queen claims. The Queen reef and the Maude St. Leger reefs both outcropped here, the former of which is reported to have been large and rich near the surface, while the latter, worked later, gave poor results. About 1880 a lease was taken up by Messrs. S. Allen and J. Marshall, and they worked the Victory and Maude St. Leger reefs for four years, but they both proved then unpayable. The latter reef was worked to a depth of 170 ft. In 1886 the mine was sold to an English company—the Phoebe Gold Mining Company, Limited. The Company prospected the deep ground by sinking a vertical shaft to a depth of 1,210 ft., which intersected reefs at 300, 477, 938, and 1,057 ft. The last-mentioned proved to be the Brilliant and several small but rich patches of ore were found, otherwise operations were unprofitable.

The Victory reef cut at 300 ft. and dipping south-east was worked from an old shaft over the southern half of the lease. An underlie shaft follows the reef right down to the east boundary, which it meets at a depth of 530 ft.

A reef, 15 in. thick, was cut at 477 ft. dipping south. It was only worked between the shaft and the south boundary by underlie shaft.

The 938-ft. reef dipping north-easterly was opened down to Kelly's Queen Block mine. The reef was small and patchy and very little stoping has been done. This reef is a continuation of the Brilliant hanging-wall reef worked in the Victory mine below the 730-ft. crosscut.

The Brilliant reef was cut at 1,057 ft. dipping north-easterly. The shaft bottomed on a poor lode but it improved as the lode was followed northerly. A small shoot, averaging about 100 ft. wide, was worked north from the shaft for a distance of 350 ft. This was worked out and in recent years the Company extended their workings on the shallower reefs, but with poor results. The Company ceased operations in 1912. The ground is held at present under G.M.L. 2081 in the name of A. Bell.

The returns from the mine for the period 1887-1912 inclusive were—Ore raised 37,028 tons, gold 39,727 oz., residues £3,535. Dividends, £17,416.

Queen Cross Mine.

This mine is situated centrally in the Queenton group of mines, about 500 yards to the east of the Charters Towers railway station. It has proved to be one of the chief producing mines of the field and is unapproached by any of the other big mines for the dividends paid on a basis of tonnage. Since 1890 137,506 tons of ore were raised for a yield of 288,494 oz. of gold, and £653,466 were paid as dividends. The lease, G.M.L. 1408, contained an area of 25 acres.

History and Production.—The ground included in the lease formerly comprised the Just-in-Time Nos. 3 and 4 North claims and portion of the Just-in-Time Block. The claims were first taken up and worked in 1873 with payable results. The Just-in-Time Block was taken up in 1876 and worked till 1888, when portion of it was amalgamated with the original Queen Cross lease consisting of 6 acres, the new lease aggregating 25 acres. Up to 1888 about 8,000 oz. of gold were won from the Just-in-Time Block. The first work on the new lease was on the "Old" Queen Cross reef, which returned 16,562 oz. of gold from 10,045 tons of ore, the dividends in 1890 and 1891 amounting to £9,300, being derived from these operations. The Brilliant reef was worked from 1895 to 1900, about 25,000 oz. of gold being won, and dividends amounting to an additional £27,500 being paid. In 1901 a crosscut at a depth of 876 ft. cut the "New" Queen

Cross reef 200 ft. east of the shaft, and the mine at once became the chief producer of the field. This was probably the richest shoot of its size on the field, for during the period 1902 to 1905 it averaged 2½ oz. of gold per ton; the ore yielded over 225,000 oz. of gold and dividends amounting to £614,166 were paid. For the greater part of this period 2s. per month on each share was distributed from the profits, and during 1903 the mine showed a profit equal to £686 for every working day of the year. This shoot was exhausted by 1907, and the vertical shaft was sunk to a depth of 2,394 ft., and a reef known as the "1,698 ft." formation was worked for several years, but with poor results. Since 1910 the mine has been idle except for a little work done by tributing parties. The following table does not include the returns from the Just-in-Time Block mine, which became amalgamated with the Queen Cross.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1890	1,156	2,129	3,600
1891	2,570	5,244	5,700
1892	1,982	2,608	..
1893	1,345	1,907	..
1894	1,555	1,985	..
1895	833	1,373	..
1896	2,662	7,894	12,500
1897	3,876	7,300	7,500
1898	4,621	6,948	7,500
1899	1,568	1,546	..
1900	1,301	1,449	..
1901	3,181	4,303	2,500
1902	16,167	41,663	116,666
1903	26,056	78,303	215,000
1904	31,793	79,686	220,000
1905	20,326	26,729	62,500
1906	7,254	6,716	..

From 1907-1910 the returns were 9,979 tons of ore, gold 9,256 oz., concentrates and tailings valued at £8,062. Dividends nil.

Underground Workings.—The Just-in-Time Block shaft was situated near the south boundary of the Queen Cross lease. This shaft cut the Just-in-Time reef at a depth of 270 ft., and from there an underlie shaft followed the reef easterly to a depth of 530 ft. Twelve levels were driven north and south, the reef being followed for 500 ft. at No. 3 level (v.d. 315 ft.). Below that the levels decreased in length owing to the ore shoot narrowing. Stoping was carried down to No. 10 level (v.d. 428 ft.) but below that the reef was considered unpayable. The main working shaft of the Queen Cross is situated close to the west boundary. It has been sunk vertically to a depth of 2,394 ft.

and from the bottom of the shaft a diamond drill bore tested the country for a further 635 ft., or to a total depth of 3,029 ft. The following is a record of the reefs intersected in the shaft.

Depth	80 ft.	—Just-in-Time reef, dipping east.
,,	501 ,,	—"Old" Queen Cross reef, dipping east.
,,	938 ,,	—"New" Queen Cross reef, dipping northerly.
,,	948 ,,	—Victory reef, dipping east.
,,	1,080 ,,	—Brilliant reef, dipping north.
,,	1,136 ,,	—2 in. quartz vein, dipping north.
,,	1,288 ,,	—6 ft. lode formation, dipping north-east.
,,	1,406 ,,	—6 ft. lode formation, dipping north-west.
,,	1,698 ,,	—Crosscut cut reef 130 ft. east of shaft, dipping east.
,,	1,976 ,,	—Vein formation, dipping northerly.
,,	2,148 ,,	—Vein formation, dipping northerly.
,,	2,310 ,,	—Vein formation, dipping northerly.
,,	2,394 ,,	—7 ft. vein formation, dipping northerly.

The "Old" Queen Cross reef was followed by an underlie shaft to a depth of 680 ft. and was worked out to that depth north of the shaft, to the New Queen Central boundary. South of the shaft the longest level (No. 6) was only driven 150 ft. The workings on the "New" Queen Cross reef are connected to the main shaft by a crosscut meeting No. 1 level at a depth of 876 ft. The reef has been worked from the south to the north boundaries from 200 ft. east of the shaft to 1,100 ft. east of the same. (See Plan 15). No. 3 level (v.d. 938 ft.) is connected to the shaft. It was from this reef that four-fifths of the output of gold from the mine was obtained.

The Brilliant reef was worked from an underlie shaft running down to the New Queen Central boundary, where the reef was worked for 400 ft. east of the shaft at No. 4 level (v.d. 1,206 ft.). Near the main shaft the reef was worked for a distance of 120 ft. to the east. No. 1 level (v.d. 1,081 ft.) was driven east 600 ft. as a prospecting level without obtaining any payable ore.

At 1,698 ft. a crosscut driven east from the main shaft cut a small reef dipping east. This was prospected to a depth of 1,778 ft. and a little stoping was done on No. 1 and No. 2 north levels near the north boundary, where the reef averaged about 1 ft. in thickness. The 1,976-ft. formation was explored for 200 ft. east, the 2,148-ft. formation for 410 ft. east, and the 2,310-ft. formation for 210 ft. east, but were all considered unpayable.

Ore Shoots.—The most productive ore shoot in the mine was worked on the "New" Queen Cross reef between 700 ft. and 980 ft. deep. This shoot, which was also worked in the Band of Hope, Victoria and Queen, and the New Queen Central mines, pitched easterly in depth, the richest portion of it passing

QUEEN CROSS REEF GOLD MINE

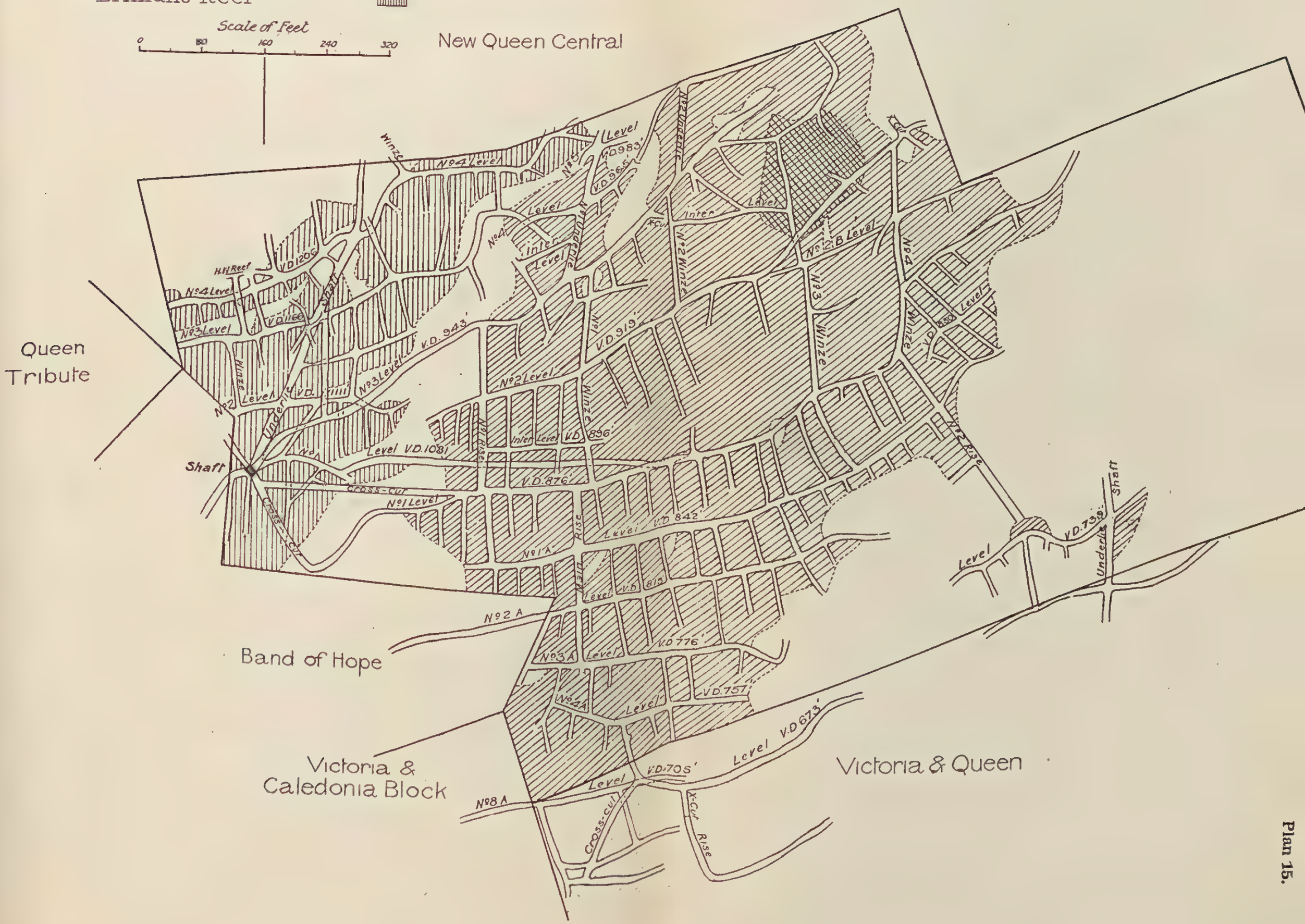
Plan of Workings

on "New" Queen Cross and Brilliant reefs

Stoping Reference

"New" Queen Cross reef
do do do H.W. reef
Brilliant Reef

Scale of Feet
0 80 160 240 320



Plan 15.

through the centre of the Queen Cross lease. The average width of the shoot in this mine was 500 ft. and the length of shoot worked 1,120 ft. The reef dips 10 deg. west of north at an angle of 20 deg. and it averaged 2 ft. in thickness. Approximately 101,000 tons of ore were won from this shoot, yielding 233,000 oz. of gold, which, allowing for recovery from residues, would average about 2½ oz. of gold per ton.

The Brilliant shoot, worked between 1,050 ft. and 1,230 ft. deep, was the eastern and deeper section of the Victoria shoot worked from near the surface in the Victoria mine. This shoot pitches easterly also, but only extends into the extreme western portion of the lease and was worked further east at greater depth in the New Queen Central and Bonnie Dundee mines. In this mine the ore won from the shoot averaged 2 oz. of gold per ton but there were some blocks of poor quality ore left unstoped.

Geological Features.— This mine would have probably been an interesting subject for investigation on account of the great enrichment of one of the reefs worked. The 938-ft. level was penetrated from the New Queen Central Mine for several hundred feet, but it was impossible to proceed further as the levels had fallen in at several points. The country rock is the normal granodiorite of the field and igneous dykes of any description do not appear to have been observed, which is quite in accordance with the examinations made of the adjoining mines. The surface indicates no detail, for where not covered with mullock heaps it is composed of a superficial layer of granitic debris devoid of outcrops. A study of the underground plan does not indicate any noticeable displacement of the reefs by faulting. All the ore-bearing fissures dip in direction between east and north at angles ranging from 20 deg. to 35 deg.

Band of Hope Mine.

The Band of Hope G.M. Company was one of the earliest companies to start operations on the field, having been formed in the year 1882. They acquired 11½ acres in the Queenton area, to the south of the New Queen Mine, which was latterly held under G.M.L. 2089 but is now cancelled. The ground taken up included the Just-in-Time Nos. 1 and 2 North claims, which had been worked with good results since about the year 1874. The Just-in-Time reef outcropped on these claims and was worked chiefly by Messrs. E. Ward, R. Coxall, and party who, prior to 1882, are reported to have obtained about 12,000 oz. of gold from the ground. The company started operations in 1883, and a shaft was put down in the north-west corner of the lease to intersect the Victory reef. It bottomed on the reef at 700 ft., and it was

worked to a depth of 810 ft. along the New Queen boundary. The returns from this reef between 1890 and 1894 were fairly good, and enabled the company to pay £2,400 in dividends. Most of the ore from the mine was obtained from the Brilliant reef (Victoria shoot). No. 3 level (v.d. 799 ft.) driven south from the shaft cut this lode near the southern boundary, and this was worked out practically right through the lease. The returns from the year 1896 to 1905 were mostly from this reef, but the "New" Queen Cross reef was also worked along the eastern boundary, and although smaller, averaging scarcely 1 ft. in thickness, it was much richer. This reef died away towards the centre of the ground. After this was worked out the returns fell away, and the company further tested the ground by sinking the vertical shaft to a depth of 1,500 ft., which exposed vein formations at 982 ft. and 1,429 ft. These were opened up, but were not payable. From 1905 onwards regular but small crushings were obtained, mostly from the old workings, but these becoming unpayable the mine was closed down in 1912.

Mr. D. Forbes, formerly manager of the mine, informed me that the ground was full of small "slides," and that there were no dioritic dykes. The trend of the " slides " was mostly a little west of north. The reef in this mine, known as the Victoria, is continuous with the No. 5 formation in the New Queen and the Brilliant "hanging-wall" reef in the Brilliant Central Mine. (See sections EF and GH—Plates 34 and 29.)

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude Oz.	£
1887–1896	9,472	13,577	3,900
1897	4,404	6,185	4,500
1898	7,935	8,164	9,000
1899	9,616	10,041	9,000
1900	10,059	12,032	19,000
1901	9,960	10,818	12,000
1902	10,637	15,846	22,500
1903	9,932	14,136	24,000
1904	4,362	5,035	7,500
1905	1,531	809	..

From 1906 to 1912, 8,546 tons of ore were raised, returning £24,118. Dividends, nil.

PAPUAN (QUEENTON) MINE.

Portion of the area in this company's lease was worked in the early days as the Papuan Block claim. The Maude St. Leger reef was worked to a depth of 200 ft. in the western half of the ground, but in this claim the reef was not rich, and the returns

do not appear to have exceeded a few hundred ounces of gold. After being abandoned it was taken up again with additional ground to the south, comprising a total area of nearly 8½ acres, and was worked by the Papuan Block Extended G.M. Company until 1892. No. 1 shaft was sunk in the north-western corner of the lease, and intersected the Victory reef at a depth of 475 ft. Very little work was done as the reef was poor. At 515 ft. the shaft bottomed on the Papuan reef, dipping north-east. This is a branch of the Victory reef, and they junction to the east of the No. 1 shaft. An underlie shaft was sunk on this to the Band of Hope boundary at a depth of 730 ft., and the northern half of the ground has been worked out. The reef ranged from 6 in. to 2 ft. in thickness, and averaged over 2 oz. of gold per ton. In 1892 the company was reconstructed as the Papuan, Brilliant, and Victoria G.M. Company, N.L. Work was continued on the Papuan reef until in 1895 the No. 2 shaft was sunk to cut the Victoria (Brilliant) reef. This was intersected at a depth of 604 ft., and followed by underlie shaft to a depth of 900 ft. The mine reached its high-water mark of production in 1896 with returns from this reef. Down to 726-ft. level the reef has all been stoped out. Below this it became patchy, but was worked to the 900-ft. level. The reef varied from 6 in. to 3 ft. thick,

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude Oz.	£
1887	836	3,046	..
1888	664	586	..
1889	759	2,284	..
1890	336	448	..
1891	229	574	..
1892	1,373	4,926	8,800
1893	1,211	3,510	5,600
1894	1,703	4,908	5,600
1895	1,612	3,477	..
1896	5,333	12,834	27,600
1897	6,435	13,205	26,400
1898	5,416	6,145	6,000
1899	2,845	2,967	..
1900	859	694	..
1901	1,526	2,712	..
1902	507	821	..
1903	1,817	1,915	..
1904	1,805	1,820	..
1905	3,033	1,483	..
1906	970	736	..

From 1907 to 1914, 2,960 tons of ore were raised, valued at £14,039.

and returned the bulk of the gold won from the mine. The No. 2 shaft cut a reef 10 in. thick at a depth of 680 ft. One level was

driven from the shaft, and the reef was stoped on a rise back to the boundary. Since 1905 the returns have been small, and the mine was mainly worked by tributers, although the company carried on prospecting work down to a depth of 1,200 ft. without success.

Early in 1917 the company resumed operations in the No. 2 shaft on a reef formation intersected at a depth of 50 feet. The reef is small and as far as exposed reveals up to 1 ft. of mineralised ore from which a party of tributers recently secured several payable crushings. The tonnage likely to be won is small, unless the reef shows considerable improvement in width in sinking further.

Clark's Brilliant, Worcester, and Victory Mine.

This mine is situated about a quarter of a mile south of the Charters Towers Railway Station, and adjoins the Victory Mine. It was until recently held under G.M.L. 1784, of 25 acres, but the ground is at present abandoned. The Worcester reef, which outcropped within the lease, is reported to have been worked in the early days of the field. The Papuan P.C. claim, in which the Maude St. Leger reef was worked, was also included in the Worcester lease. These reefs were small, and the output from the claims was not large, although they are said to have carried rich ore occasionally. Mr. John Clark acquired an interest in the mine about 1878, and later the Worcester G.M. Company was formed. The company suffered many reconstructions, for the mine has proved disappointing in its returns, although it has been worked constantly since 1890, either by the company or tributers, up to the year 1913, when it was closed down.

The returns from 1890 to 1912 were 15,449 tons of ore for a yield of 26,454 oz. of gold. Dividends, £16,350.

Three shafts have been put down on the lease. No. 1 shaft is an underlie sunk on the Worcester reef to a depth of 363 ft. This reef was small and patchy. From a footwall crosscut, at a depth of 253 ft., a small but rich reef was worked out to the boundary north of the underlie shaft. To the south of the shaft the Worcester reef was unpayable, practically all the stoping being confined to the north side. Below the No. 6 level Tuckett's reef was worked in the extreme north-east corner of the ground as far as the boundaries permitted. It was small but very rich, a crushing of 53 tons returning 406 oz. of gold bullion. These three reefs were poor south of the No. 1 shaft.

No. 2 shaft, near the west boundary, was sunk to intersect the Brilliant lode as near as possible to the pay shoot on that lode in the Victory Mine. At a depth of 429 ft. the lode fissure was

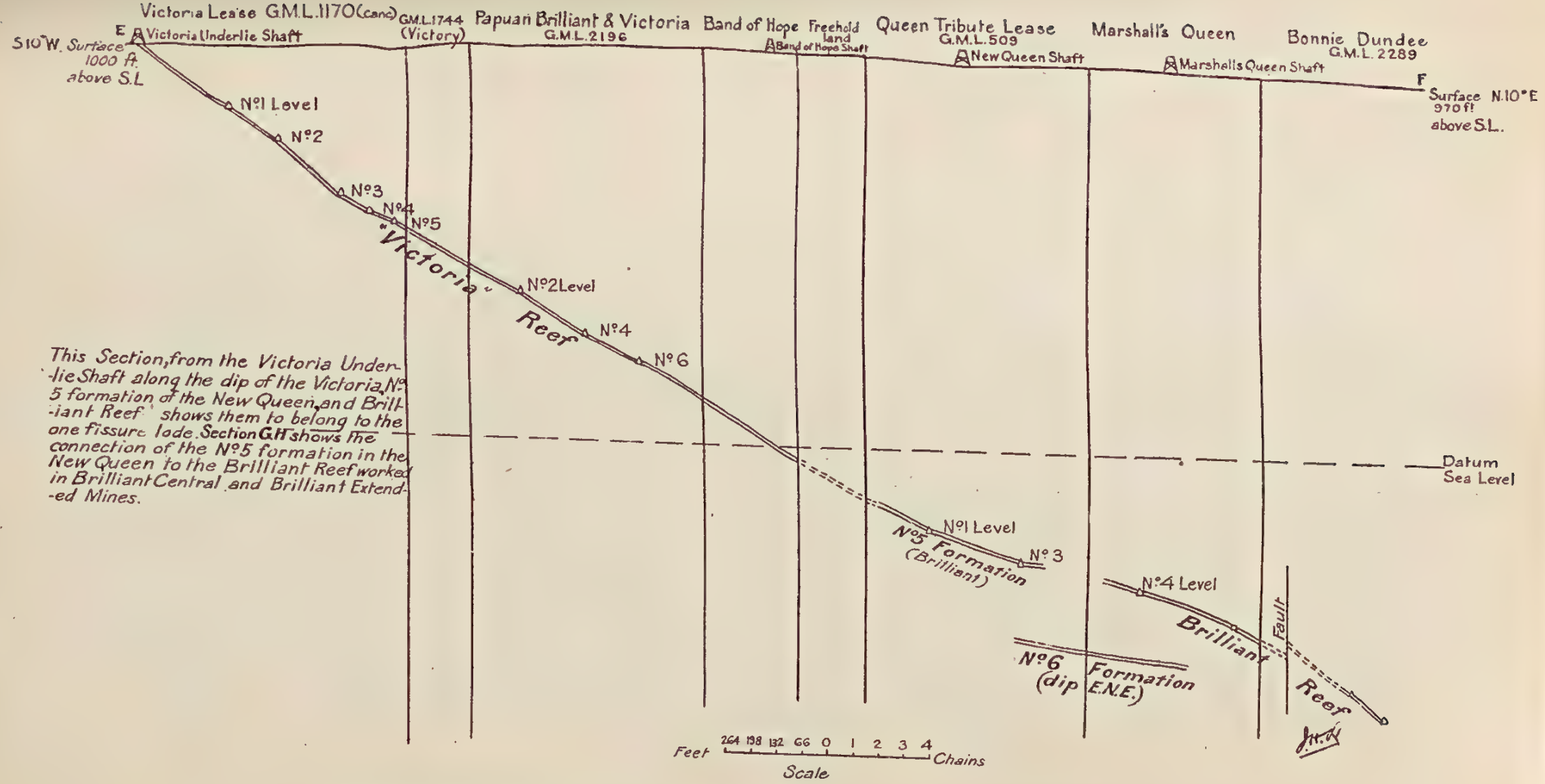
penetrated, and two levels were driven east. No. 2 level (v.d. 475 ft.) is about 500 ft. long, but no payable ore was disclosed by these operations. This shaft was later continued to a depth of 1,041 ft., and cut twelve small vein formations, which do not appear to have been worth testing.

No. 3 shaft (vertical) is 1,768 ft. deep. From a depth of 588 ft. an underlie shaft was sunk for 520 ft. towards the north-east corner of the lease, and it cut the Victoria shoot on the Brilliant reef at a depth of 690 ft. No. 1 level was driven east 300 ft. to the boundary, and a rich block of ore was stoped below the level. Nos. 4 and 5 levels in the Victory Mine, on the same ore shoot, were driven west into Clark's Worcester as far as the underlie shaft, to which they are connected by short rises, but they proved that the shoot above No. 1 level (Clark's) had died out. At a depth of 768 ft. a vein formation, cut in the vertical shaft, was sunk on to a depth of 901 ft. This reef was worked over a small area underlying the Worcester workings. The straight shaft was continued to the depth of 1,768 ft. in order to test the ground as to the possible continuation of the Day Dawn lode to the east. Nothing encouraging was found, and prospecting work in the mines to the north-west has proved that the Day Dawn fissure does not extend further east than the Brilliant P.C. lease. The plan of the workings shows the slight dislocation of the Worcester and underlying reefs by three apparently vertical faults trending north-east to south-west. The downthrow, which is to the north-west, is not more than 10 ft. in any instance, and it is significant that the enrichment of all the reefs worked is confined to the north-east corner of the lease which the faults traverse. Elsewhere in the mine the reefs have been impoverished, but sufficient data is not available from the records of adjacent mines, in which work has long been suspended, to enable a definite conclusion to be formed as to the influence of these small faults on the enrichment of the reefs. The same enrichment near fault intersections has been noted in several widely separated mines, but it has been pointed out in the general discussion of the origin of the ores that as far as the principal ore shoots of the field are concerned there is no conclusive evidence of enrichment along fault fissures.

Victoria Mine.

This mine is situated in the south-western section of the Queenton group of mines. It was first taken up by Mr. Hugh Mosman and the Victoria G.M. Company was formed to work the lease, G.M.L. 1170, of 25 acres. The company suffered many reconstructions, for up to 1888 the main shoot of ore had not

been found and financial difficulties hampered the development of the mine, which since proved to be one of the best paying on the field. The ore won was exceptionally rich, averaging 2½ oz. of gold per ton for the whole output, and although the tonnage of ore raised was comparatively small compared with the chief mines of the field the dividends distributed were only exceeded by seven of those. Between the years 1888 and 1902, 60,904 tons of ore yielded 146,940 oz. of gold, and the dividends amounted to £259,000. The company ceased operations in 1904 and the mine is still closed down. The ore has all been won from the Victoria shoot on the Brilliant lode. The reef worked here has always been regarded as distinct from the Brilliant. A study of the underground workings of the reef in this mine and in the Papuan, Victory, Clark's Worcester, Band of Hope, and the Victoria and Caledonia Block mines, where it was also worked, shows that the strike of the reef except for local deflections, is nearly east and west and the direction of dip 3 deg. to 5 deg. east of north. Hitherto all maps and plans of the field published have shown the Victoria reef dipping to the north-east and east, but this is inaccurate and has proved misleading in prospecting the eastern section of the field. Vertical sections based on the underground plans show that the Victoria reef, worked in this mine and in the Papuan and Band of Hope mines, is continuous with the Brilliant reef in the New Queen (Queen Tribute), Brilliant Central, and Brilliant Extended mines, although the two latter have worked distinct ore shoots from the others (see sections E., F., and G., H. plates 34 and 29). Between these two big shoots of the Brilliant lode is a zone of country in Clark's Worcester and Victory mines, about 1,000 ft. wide, in which the Brilliant lode was impoverished. Here the fissure has never been followed through, but the Victoria workings in Clark's Worcester No. 3 shaft, which can be followed from the Victoria mine, correspond in depth and attitude with the Brilliant workings in the western ground of the Victory, which carried the ore shoot down into the Brilliant P.C. Mines. This has not been relied on to prove that the Victoria and Brilliant are one and the same lode; the section proves that, and this evidence is in agreement with it. All along the line of the Brilliant lode fissure, from the surface to the greatest depth attained, the country rock is greatly fissured—the section in No. 1 West Victoria and the record of No. 1 shaft, Victoria and Caledonia Block Mine, denotes this—and these subsidiary fissures often contain pay shoots while the main lode is temporarily small and impoverished. This has often led to confusion in identifying the main fissure of the Brilliant lode underground.


Victoria Lease G.M.L.1170(cane)
G.M.L.1744 (Victory)
Papuan Brilliant & Victoria G.M.L.2196
Band of Hope
Freehold land
Queen Tribute Lease G.M.L.509
Marshall's Queen
Bonnie Dundee G.M.L.2289
E
Victoria Underlie Shaft
S10°W. Surface 1000 ft. above S.L
Band of Hope Shaft
New Queen Shaft
Marshall's Queen Shaft
F
Surface N.10°E 970 ft above S.L.
No1 Level
No2
No3
No4
No5
"Victoria" Reef
No2 Level
No4
No6
This Section, from the Victoria Underlie Shaft along the dip of the Victoria, No 5 formation of the New Queen, and Brilliant Reef shows them to belong to the one fissure lode. Section G.H shows the connection of the No5 formation in the New Queen to the Brilliant Reef worked in Brilliant Central and Brilliant Extended Mines.
Datum Sea Level
No1 Level
No5 Formation (Brilliant)
No3
No4 Level
Brilliant Reef
Fault
No6 Formation (dip E.N.E.)
Feet 264 198 132 66 0 1 2 3 4 Chains
Scale

Vertical Section along line E.F. (see plans of leases) plotted from plans of Workings

Ore Shoots.—The Victoria shoot pitches to the east in depth. The outcrop of the reef was poor, the shoot starting at a depth of 90 ft., and it has been worked to a depth of 1,450 ft. in the Bonnie Dundee Mine. The greatest width of shoot was 700 ft., between the depths of 400-and 650 ft. In this mine the shoot averaged 2½ oz. of gold to a depth of 800 ft. Parts of it were abnormally rich, annual returns sometimes reaching an average of nearly 5 oz. The reef averaged 1 ft. in thickness.

Underground Workings.—The mine was first worked from a vertical shaft near the centre of the lease. This cut a reef at a depth of 247 ft. and it was followed by an underlie shaft for 600 ft. before the Victoria shoot was found. This gave such promise that an underlie shaft was sunk from the outcrop of the lode to the north-eastern corner of the lease, and from this the mine was worked. The shaft was sunk north-east, after east, obliquely to the direction of dip of the reef, and fifteen levels were opened, most of them the full width of the lease. The reef has all been stoped below the 100-ft. level, except for a few blanks on the south-east boundary. Along the Papuan and Band of Hope mine a rich footwall vein was worked. At a depth of 428 ft. a crosscut runs south-west for 600 ft. where it cut a vein formation. A vertical shaft connects with the surface at that point and an underlie shaft put down 660 ft. on the formation, which proved unpayable.

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1887	9	18	..
1888	1,162	1,889	..
1889	1,528	6,669	12,400
1890	1,489	7,246	16,200
1891	1,690	8,082	14,400
1892	5,217	18,384	41,400
1893	6,864	15,684	32,400
1894	7,666	13,245	21,600
1895	8,529	17,226	32,400
1896	7,235	13,297	25,200
1897	7,060	12,182	21,600
1898	7,108	11,236	21,600
1899	7,182	10,338	14,400
1900	5,156	7,334	5,400
1901	2,333	3,370	..
1902	685	768	..

VICTORIA No. 1 WEST MINE.

This abandoned mine is situated in the western quarter of the Queenton group of mines and immediately north of the well known Victoria mine. It has produced very little gold although

adjacent mines have been conspicuous for their big yields of the metal. The ground was known as the Little Worcester claim in the early days and was prospected with indifferent success to a depth of 60 ft. A local company took up the ground later, the lease having an area of 4½ acres. No. 1 shaft was sunk near the western boundary and cut vein formations at 102 ft., 275 ft., and 335 ft. The two shallower ones were valueless, but in the lowest a block of ore was intersected which cut out within a few feet. This formation was considerably prospected, but no further ore was found. An underlie shaft was sunk for 270 ft. on it, and two levels (v.d. 335 and 402 ft.) were driven several hundred feet. A crosscut was put in 300 ft. east from the bottom level to cut the shallower veins, but without any encouragement. In 1891 the company was reconstructed and the south-eastern corner of the lease opened up by No. 2 shaft. The following section shows the reefs cut and some of the workings and is of

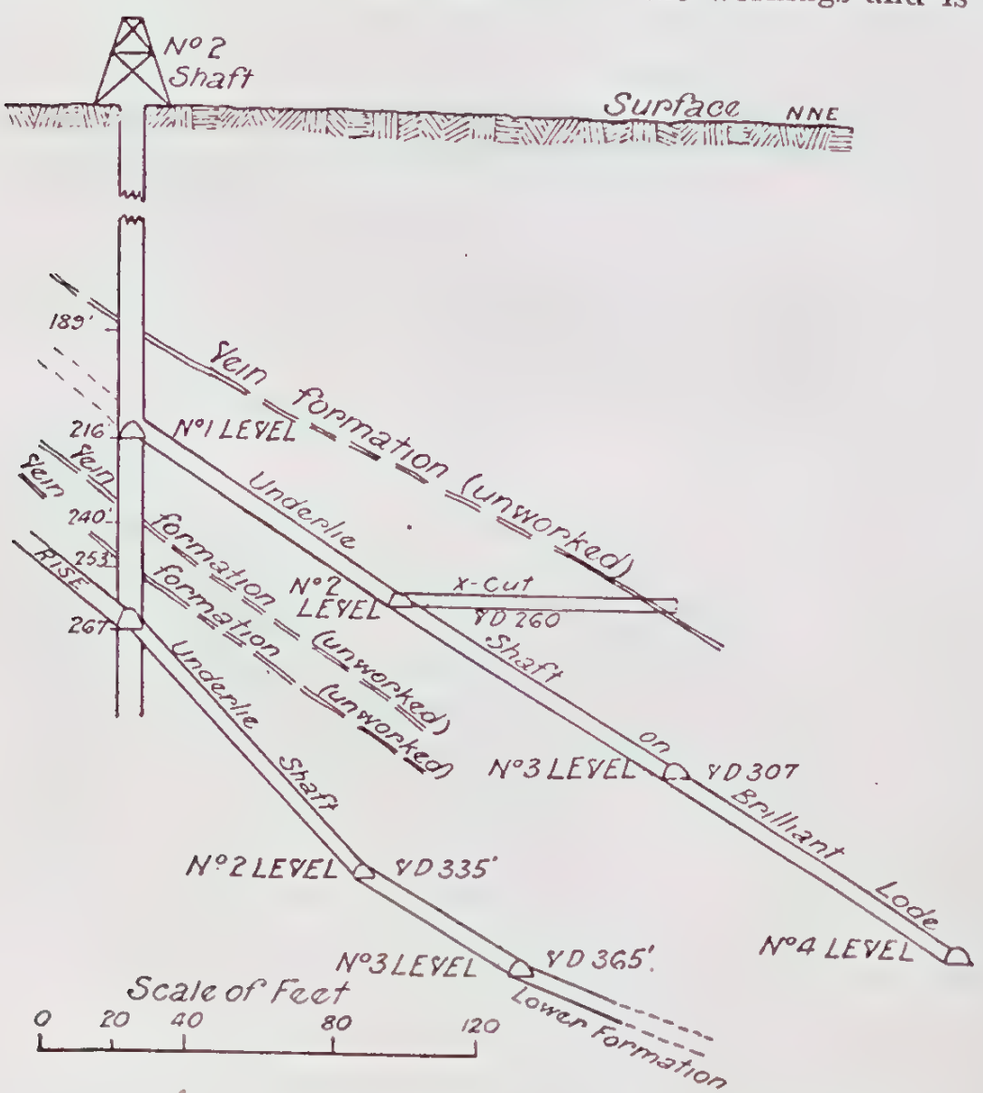


Fig. 10.—Section of No. 1 West Victoria Mine Workings.

interest, for the large formation cut at a depth of 210 ft. is the upward continuation of the main Brilliant fissure in this part of the field, and the section shows to what extent the main fissures

of the field are associated with subsidiary parallel fissures, which have invariably proved to be branches of the main lode and in many instances carried highly payable ore shoots.

The vein formations at 189, 240, and 253 ft. have not been worked. The Victoria (Brilliant) reef, dipping north 20 deg. east and cut at 216 ft., was followed by underlie shaft to a depth of 360 ft. It carried a payable reef to the south-east of the shaft and most of it has been stoped out to the lease boundary. On the north-west side the shoot failed and No. 3 level (v.d. 307 ft.) was driven 400 ft. without finding payable ore. The shoot worked was a fringe of the famous Victoria ore-shoot, worked in the adjoining mine, and between the years 1898 and 1900 about 2,500 oz. were won from it. The reef cut at 267 ft. disclosed a large fissure. This was followed to a depth of 460 ft. and levels were opened at 280, 335, 392, and 451 ft. This work proved unpayable but a little ore was stoped between Nos. 1 and 3 levels, 250 ft. north-west of the shaft. From 1893 to 1900 the mine yielded 2,958 oz. of gold. The lease was shortly afterwards abandoned and was later incorporated in the Union Jack Consolidated Mines.

Victoria and Caledonia Block Mine.

This mine, now closed down, was originally held as Just-in-Time Nos. 1, 2, and 3 South claims. Like all the ground in that part of the Queenton area, it has been worked from the very early days. The Just-in-Time outcropped a few yards to the west of this mine and was worked by the prospectors in this ground to a depth of about 150 ft. Below that it was unpayable. Mr. Tom Kelly bought an interest in the claims and a lease (G.M.L. 429) of 10¾ acres was eventually taken up. The mine was known as Kelly's Caledonia until 1898, when the Victoria and Caledonia Block G.M. Co. was formed. This Company has continued operations both on the Victoria (Brilliant) and Caledonia reefs. From 1899 to 1903 the mine was a very profitable one, but since then the returns have been small. In 1908 the company was reconstructed and the New Victoria and Caledonia Block G.M. Company carried on operations till 1911, when the mine was closed down. It has been worked from two surface shafts. No. 1 shaft, near the south boundary of lease, intersected the Just-in-Time reef at a depth of 170 ft., veins formations at 297 ft. and 425 ft. respectively, the Caledonia reef at 450 ft., and a reef at 659 ft. The Just-in-Time reef, dipping easterly, was unpayable and was not worked. The 297-ft. reef, dipping north, was opened up to a depth of 578 ft. by an underlie shaft. The reef was very narrow, but on the east of the shaft the ground has been stoped to the Victoria and Queen boundary.

The ore averaged about 1 oz. of gold. This is probably the continuation of the "New" Queen Cross reef (see section G-H, plate 29) worked in the mines immediately to the north to a depth of 950 ft. West of the shaft no payable ore was found. The 425-ft. reef, dipping north, was opened up by an underlie shaft for a distance of 120 ft. One level was put in, but being unpayable no further work was done. The Caledonia reef, cut at a depth of 450 ft., furnished most of the ore obtained from No. 1 shaft. It dips north-easterly at about 30 deg. and an underlie shaft was sunk along the reef for 300 ft. It is reported to have not been rich, but to the east of the shaft, about No. 3 level, the south-eastern corner of the lease has been worked right out. To the west of the shaft the ore was stoped for a distance of 100 ft., further west it became unpayable. The 659-ft. reef was unpromising and very little work was done. The No. 2 shaft on the western boundary bottomed on the Victoria (Brilliant) reef at a depth of 740 ft. An underlie shaft was sunk on it to the Queen Cross boundary at a depth of 890 ft. At about 100 ft. down the underlie the big Victoria shoot was penetrated and almost all of the reef north of the shaft has been stoped out. This reef was very rich, often averaging 2 oz. of gold per ton and most of the returns from 1899 to 1903 came from this shoot.

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
Kelly's Caledonia.			
1893-8	..	8,540	2,400
Victoria and Caledonia Block.			
1899	2,980	5,408	7,200
1900	4,992	8,841	9,600
1901	5,044	7,468	4,800
1902	6,406	12,166	30,000
1903	7,357	8,225	12,000
1904	1,047	2,065	..
1905	1,363	1,358	..
1906	..	..	..
1907	780	596	..

From 1908 to 1911 the New Victoria and Caledonia Block Gold Mining Company raised 6,780 tons of ore, valued at £15,677.

CRAVEN'S CALEDONIA MINE.

This mine is situated to the south of the Queenton group of mines and close to Millchester. The ground was taken up by Mr. Richard Craven in 1882 and Craven's Caledonia G.M. Company N.L. was formed to work it. The area of the lease was 25 acres. The Just-in-Time reef was worked to a depth of 240 ft.

but the returns were so poor that the company failed. After a cessation of operations Mr. Craven again worked the mine, and in 1891 a local company was formed and opened up the Caledonia and "Victoria and Queen" reefs. On the former a very rich shoot was struck and between 1893 and 1899 the returns enabled a distribution of £12,500 as dividends to be made. After that no further ore reserves were discovered and the returns fell away. In 1906 the Company was reconstructed as the New Craven's Caledonia G.M. Co. The mine was worked till 1911 with poor results and then closed down. All the payable ore came from the north-eastern section of the lease. A vertical shaft was sunk there and cut the Just-in-Time reef dipping easterly at a depth of 198 ft. An underlie was sunk on this to a depth of 250 ft. and 2 levels were driven. No. 1 south is 250 ft. long and No. 1 north 120 ft. The reef was poor, but the underlie shaft was continued until it cut the Caledonia fault hading south-east at an angle of 70 deg. The Caledonia reef is thrown down 80 ft. on the east of this fault but it was picked up on both sides of the faults and worked through crosscuts from the shaft parallel to the strike of the fault, *i.e.*, north-east. The pay ore extended from 400 ft. south of the shaft, thence north-easterly to the Victoria and Queen Mine and for approximately 200 ft. on each side of the fault. On the northern boundary the "Victoria and Queen" reef, lying 70-ft. vertically above the Caledonia, furnished a small block of payable ore. Beyond these reefs no pay ore was discovered.

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1882-1889	4,161	7,633	..
1890	532	2,357	..
1891	1,327	3,820	..
1892	1,518	3,329	..
1893	3,321	7,886	7,500
1894	2,977	6,166	2,500
1895	2,244	3,232	..
1896	1,616	2,110	..
1897	1,483	2,238	1,250
1898	1,567	2,175	..
1899	1,666	2,209	1,250
1900	241	392	..
1901	772	934	..
1902	11	12	..
1903	716	497	..

From 1906 to 1911 the New Craven's Caledonia Gold Mining Company raised 1,152 tons of ore, valued at £4,598.

Millican's Caledonia Mine.

This mine, held under G.M.L. 1682 (area 25 acres), adjoined Craven's Caledonia Mine on the east. It was worked between the years 1894 and 1900, but turned out poorly and very little exploratory work was done. A shaft was sunk to a depth of 380 ft. and a vein formation followed north-easterly to a depth of 514 ft. A crosscut from this north-westerly picked up the Caledonia shoot near Craven's Caledonia boundary. This was worked between the 460-ft, and 540-ft. levels from the boundary for a distance of 140 ft. east, where the shoot ended. No. 2 and 3 levels are connected to Craven's workings. From 1895 to 1899 2,137 tons of ore were raised, yielding 2,874 oz. of gold. Dividends amounted to £900. After 1899 the mine was on tribute for several years and the ground was subsequently taken up by the Victoria and Queen G.M. Company.

Victoria and Queen Mine.

This mine is situated in the south-eastern quarter of the Queenton area and adjoins the southern boundary of the Queen Cross Mine. The Victoria and Queen G.M. Company was formed in 1891 to work this ground and G.M.L. 1,409, area 25 acres, was taken up. A vertical shaft was sunk in the south-western corner of the lease, which cut the "Victoria and Queen" and the Caledonia reefs. The former has been worked to the northern boundary, mainly to the west of the Caledonia fault, which strikes north-easterly through the centre of the ground. During this period—1893 to 1901—returns were good and the Company paid £16,800 in dividends from operations on that reef. The richest portion of the lease had not been opened up, however, for the discovery of the "New" Queen Cross reef in the Queen Cross Mine induced the Company to prospect the ground along the northern boundary. A small section of the ore shoot—one of the richest on the field—cut across the north-western corner of this mine. It was worked out in three years, but the returns for the years 1902 and 1903 reflect the richness of the ore, as it enabled the Company to pay £49,150 dividends in the two years. A considerable amount of prospecting work was done on these two reefs along the Queen Cross boundary, but no payable ore was found in the eastern ground. During recent years the output was mainly derived from tributers, but the Company has done exploratory work on the Just-in-Time and Caledonia reefs without discovering any fresh reserves of ore. The mine was closed down in 1911. From 1893 to 1910, 35,730 tons of ore was raised, yielding 63,920 oz. of gold, an average of nearly 2 oz. per ton. Dividends paid amounted to £66,225.

The vertical shaft cut vein formations at 380- and 468 ft. respectively, the "Victoria and Queen" reef at 512 ft., and the Caledonia reef at 593 ft. The shaft bottomed on the reefs to the east of the Caledonia fault (downthrow side). An underlie shaft was sunk on the "Victoria and Queen" reef from 512-ft. level until it intersected the fault. A small rich block of ground was worked out here close to the shaft (151 tons crushed for 646 oz. of gold), but most of the ore came from the reef on the west side of the fault, which was picked up by northerly crosscuts from the shaft. Down to No. 3 west (v.d. 543 ft.) the reef was worked out to the west boundary. From No. 3 west level an underlie shaft was sunk on the reef to the Queen Cross boundary, stoping being limited to the western half of the lease. In the north-west corner the "New" Queen Cross reef was worked and the workings are connected to those in the Queen Cross Mine.

A little work was done on the Caledonia reef on the 593-ft. level east of the shaft; but the ore shoot on this reef, worked in Craven's Caledonia Mine, only extended a few feet over the boundary and two levels driven to the east did not open up any payable ore.

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1893	151	646	..
1894	834	1,325	..
1895	865	1,374	..
1896	2,430	6,266	6,000
1897	3,518	6,749	2,400
1898	6,280	9,961	7,200
1899	5,395	6,432	1,200
1900	387	317	..
1901	422	550	..
1902	1,299	2,731	4,800
1903	8,312	19,913	44,350
1904	2,139	2,179	..
1905	647	1,157	..

From 1906 to 1910, 3,051 tons of ore were raised, valued at £12,414.

LADY CARRINGTON (FORMERLY CALEDONIA) MINE.

This mine was situated on a lease of 25 acres (G.M.L. 1,612), lying immediately to the south of the Queenton group of mines and to the east of the Victoria Mine. The lease included the ground worked in the early days of the field as the Caledonia P.C. and No. 1, 2, and 3 South Caledonia claims. The Caledonia reef outcropped in the P.C. claim and was discovered about 1872 by Messrs. Greaves, Harrison, and Rodgers. Several other small reefs outcropped and the ground was extensively worked near the surface, as the number of potholes and shallow shafts

indicate. Complete records of crushings are not obtainable, but most of the gold came from the P.C. claim. Nos. 1, 2, and 3 South claims were worked principally by Blake and party, but are reported to have been disappointing. A vertical shaft was put down 2½ chains north of the Caledonia outcrop and cut the reef at a depth of 80 ft. It was worked down to a depth of 260 ft. and then abandoned. The ore shoot worked was very rich, the crushings for the year 1899 averaging as high as 6½ oz. of gold. It was in these workings that most of the gold was won. The 200-ft. level is 250 ft. long and this was the greatest width of the shoot, the ends being in unpayable country. This shoot follows the intersection of the Caledonia fault and the reef for a distance of 300 ft. In the north-west portion of the lease a shaft was sunk 570 ft., but the Victoria (Brilliant) and Caledonia reefs were poor. The former was cut at a depth of 280 ft. and opened up to a depth of 350ft. The 302-ft. level was driven south 250 ft. on a crossvein, but it was also unpayable. The only other workings of any importance are on a reef which outcropped along the south-west boundary. An underlie shaft was sunk on this to a depth of 420 ft. and then abandoned as unpayable.

In 1892 the Lady Carrington Company took up the ground. They extended the old workings on the Caledonia reef but the returns were insignificant.

The returns obtainable are as follows:—1875-1888, Caledonia Claim and P.C. Mine, 3,486 tons ore, 12,284 oz. gold. 1892-1901, The Lady Carrington Mines, 281 oz. gold.

North Queen Mine (formerly No 6 N.E. Queen and lately the Bonnie Dundee North).

This mine adjoins the Bonnie Dundee Mine to the east. It was held under G.M.L. 2,092, area 24½ acres, and was originally known as the No. 6 North-east Queen claim. It appears to have been first worked about 1878 by Templeton, Sloan, and party. In 1885 the North Queen G.M. Company was formed to work it, but since then it has produced very little gold. From 1881 to 1885 it was considered one of the richest claims on the field, all the ore being obtained from the Queen reef, which has been worked to a depth of about 500 ft. The returns were:—

1882	..	..	526 tons of ore, 1,170 oz. gold
1883	..	..	2,107 tons of ore, 2,350 oz. gold
1884	..	..	2,397 tons of ore, 7,505 oz. gold
1885	..	..	5,360 tons of ore, 10,788 oz. gold
1886	..	..	3,617 tons of ore, 5,300 oz. gold
1887	..	..	1,115 tons of ore, 1,289 oz. gold
1888	..	..	357 tons of ore, 199 oz. gold
1889	..	..	612 tons of ore, 976 oz. gold

Three shafts have been put down on the Queen reef. No. 1 shaft, near the west boundary, cut the reef at 275 ft. and it was worked to a depth of 470 ft. Four levels were driven to the west boundary. On the east, No. 2 was driven 400 ft. on a good shoot of ore. The reef is reported to have been 6 ft. thick in places, but in quality it was found to be patchy. No. 2 shaft was put down near the centre of the lease and the reef opened to a depth of 400 ft. It was tested for a distance of 400 ft. by two levels, but no payable ore was found. Further east, near the No. 7 N.E. Queen Mine, No. 3 shaft was put down, cutting the reef at 200 ft. The underlie shaft followed the reef down for 400 ft. and a level (v.d. 234 ft.) followed the reef for 250 ft., but it was again unpayable. It cut the Brilliant (?) fissure at 1,470 ft. and it was tested to a depth of 1,550 ft. No. 1 level (v.d. 1,470 ft.) was driven 500 ft. east and 100 ft. west. No. 2 east level (v.d. 1,539 ft.) was put in 500 ft. also, but no payable ore was found. About the end of 1915 the lease was again taken by and renamed the Bonnie Dundee North. The shaft was further sunk to a depth of 1,768 ft. in search of the formation being worked in the Bonnie Dundee adjoining. A formation was cut at 1,733 ft. but no other work was done and operations were abandoned in 1916.

No. 7 North-East Queen Mine.

The mine (later known as the Queen Central Block) is situated in the eastern section of the Queenton group of mines. It embraced an area of 19½ acres held under G.M.L. 512. The ground is reported to have been worked prior to 1879 to a shallow depth with very little success, but it was not until 1881 that the Queen reef, which has furnished practically the entire output of the mine, was first worked by J. Wilson, H. Collins, and party. The reef was poor near the surface, but later the No. 7 N.E. Queen G.M. Company was formed and the lode was worked to a depth of 750 ft. with payable results for a few years. Most of the lode was unpayable, but the rich payshoot worked in the Golden Gate Mine to the east was picked up along the eastern boundary on No. 3 and No. 4 levels. From 1890 for a period of three years this shoot was worked out between No. 1 level (v.d. 144 ft.) and No. 7 (v.d. 608 ft.) for about 200 ft. along the boundary. Between No. 5 and No. 6 levels the shoot pitched to the west and was worked out as far west as the underlie shaft, where it died out. It yielded about 26,000 oz. of gold, but beyond this the reef was poor although it has been worked a little to the west of the shaft. The shaft was later sunk to a depth of 730 ft. and No. 7 level (v.d. 608 ft.) driven 200 ft. west, but no further pay ore was found. Most of the ore from the west of the shaft came from between No 1 and No. 4 levels.

From 1902 to 1908 the ground was further prospected by the Queen Central Block G.M. Company, but nothing payable was obtained.

The returns from 1890 are as follows:—

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1890	2,710	3,116	1,500
1891	5,007	7,776	10,200
1892	6,376	14,846	24,000
1893	2,164	1,596	..
1894	867	843	..
1895	726	869	..
1896	809	1,331	..
1897	794	1,177	..
1898	705	1,040	..
1899	768	616	..

Golden Gate Mine.

This mine is situated on the eastern extension of the Queen lode and to the east of the Queenton group of mines. The ground worked was held under G.M.L. 1,406, area 23 acres. The lease was first taken up about 1882, the Golden Gate G.M. Company was formed in 1884, and operations were commenced by sinking a vertical shaft, which cut the Queen reef at a depth of 160 ft., and an underlie shaft was sunk on the reef several hundred feet. No payable ore was found, but when the mine was at its lowest ebb, in the year 1888, a rich ore shoot was cut and for the seven years following operations were very profitable, 55,000 oz. of gold being obtained. When this shoot was worked out the lease was amalgamated in 1898 with the Sunburst lease, and additional ground to the north was taken up for the purpose of testing the deeper levels.

The Queen and the Sunburst reefs have been worked in this mine. They dip northerly at an angle of 40 deg., the latter being a branch on the hanging-wall of the Queen reef with which it junctions at the shaft on the 430-ft. level.

The mine was worked from an underlie shaft from the outcrop of the Queen lode, which was sunk on to a depth of 600 ft. Six levels were driven on the reef from the east to west boundaries between the depths of 180 ft. and 574 ft. Two levels were driven on the Sunburst reef east of the shaft (v.d., 370 ft. and 430 ft.).

West of the shaft all the reef has been stoped out to the boundary between 200-ft. and 500-ft. levels. On the east of the shaft the ore was restricted to the same levels, but there were a

number of blank areas. A little ore was obtained on the two levels on the Sunburst reef, but the bulk of the returns came from the Queen reef.

The country rock in this mine and in the mines further east on the Queen lode is a quartz-diorite, which is considered to be a differentiate of the normal grano-diorite magma. Compared with the grano-diorite of the field proper it is coarser grained and hornblende (replacing much of the biotite) is an abundant constituent. From here extending east, the country rock is much intruded by dykes of siliceous and sub-siliceous rocks. Of the latter two distinct series can be identified, similar in appearance to the diorite-porphyrite dykes of the central portion of the field, to which they are apparently genetically related, although they are marked by an absence of the regularity of strike which characterises the former. A diamond drill bore was put down from the bottom of the vertical shaft (depth 280 ft.) to a depth of 3,006 ft., the core recording "grey granite" to the bottom. No reefs were intersected in the bore but numerous seams of quartz, sometimes mineralized, less than 2 in. thick, were recorded. Nothing is indicated in the record warranting development.

PRODUCTION.

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1888	330	816	..
1889	3,617	7,519	..
1890	4,034	7,278	6,600
1891	10,169	16,059	18,600
1892	10,844	17,802	24,300
1893	2,713	2,941	..
1894	2,029	2,482	..
1895	933	1,148	..
1896	634	581	..

THE SUNBURST.

This mine is, with the exception of the East Sunburst, the most easterly situated on the Queen lode. It takes its name from the Sunburst reef, which outcropped on the lease, and the ground was first worked as a claim by a prospector named Morris in 1882, who is reported to have worked the Sunburst reef to a depth of 50 ft., crushings averaging 2 oz. of gold per ton. The vein was only a few inches thick, and on reaching water level the claim was abandoned. In 1884 the ground (25 acres) was taken up under lease (later G.M.L. 1,367) and the Sunburst G.M. Company worked the ground from that time. The output has not been large, but a very rich shoot was struck on the Sunburst

reef near the western boundary, between 200 ft. and 350 ft. deep, the crushings from which during 1890 and 1891 averaged 3 oz. of gold per ton. The mine was worked by tributers up to 1897 and was then amalgamated with adjoining leases for the purpose of prospecting the deeper ground.

The mine was worked from two vertical shafts. The P.C. shaft, near the south boundary, cut the Queen reef at a depth of 112 ft. and an underlie shaft was sunk to a depth of 250 ft. on the reef, levels being opened up for about 400 ft. A small shoot 60 ft. wide was worked to the west of the shaft down to the 233-ft. level. Below that the reef was unpayable. The main shaft (now known as the Sunburst and Golden Gate Extended) cut the Sunburst reef at a depth of 189 ft. The underlie shaft followed the reef to the north boundary at a depth of 500 ft. Four levels were driven and the reef opened up for a distance of 600 ft. from the west boundary. From the vertical shaft down to the 354-ft. level a rich shoot was worked between the underlie shaft and the west boundary. A little ore was also stoped on No. 1 and No. 2 east levels. A crosscut has recently been driven south from the vertical shaft at a depth of 140 ft. by a party of miners to intersect the pay shoot on the reef above the shaft, if it extends that far. So far no payable ore has been located in this work.

The geology is similar in every respect to the Golden Gate mine, briefly described previously. The mine returns for the period 1887 to 1896 were 10,409 tons of ore raised, yielding 20,204 oz. of gold. Dividends paid from 1891 to 1893 amounted to £24,000.

East Sunburst.

This mine—never more than a small prospect—was situated on the eastern extremity of the Queen lode. Very little work was done and the returns were small. An underlie shaft was sunk on the Queen reef to a depth of 450 ft. and levels were driven for a distance of 250 ft. On the east of the shaft the fissure was barren. Most of the ore came from the west of the shaft below the 254-ft. level. From 1893 to 1896 the mine yielded 4,901 oz. of gold. The ground is now abandoned.

Queen Deeps Mine.

While the Golden Gate and the Sunburst mines were working with success on the Queen reef the land immediately to the north of those mines was taken up by two companies known as the Queen Consols and Queen Consolidated respectively. They opened up the Queen reef in two vertical shafts and did a considerable amount of prospecting work, demonstrating the per-

sistence of a large but unpayable reef. After operations ceased in the Golden Gate and Sunburst mines in 1897 two leases, aggregating an area of 65 acres, were taken up, embracing portions of the No. 7 N.E. Queen, Golden Gate, Sunburst, Queen Consols, and Queen Consolidated leases, for the purpose of deep-sinking and testing the Queen lode at a greater depth than previously worked. Up to 1911 the Queen Deeps Company did a large amount of prospecting work on the Queen reef down to a depth of approximately 1,400 ft., but the trial crushings obtained over a period of five years did not average 7 dwts. of gold. The chief prospecting work accomplished was the sinking of the old Queen Consols shaft vertically to a depth of 1,100 ft. without intersecting anything payable. The Queen reef, which had been cut at 815 ft. deep, was followed by an underlie shaft to a depth of 1,332 ft. Six levels were opened up to distances of 300 ft. from the shaft. On these workings the reef is reported to have attained a thickness of 8 ft. occasionally, but the ore was hopelessly low grade. The Sunburst levels in the Queen Consolidated shaft were also extended, but nothing payable was located.

The returns from the trial crushings are appended.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.
	Tons.	Crude oz.	£	£
1907	1,768	406	1,790	2,983
1908	336	82	505	741
1909	78	21	84	143
1910	39	5	44	59

Vesuvius Mine.

The Vesuvius lease, G.M.L. 2,020, area 39½ acres, was situated on the east side of the Queen Central and Queen Cross mines. The ground was first taken by Mr. John Hunter and was known as the Eastern Queen. In 1893 the Vesuvius G.M. Company was formed and a vertical shaft was started on the western boundary, which was sunk to a depth of 1,200 ft. without encountering any payable reefs. Vein formations were cut at 115, 683 (Just-in-Time reef), 905, 1,039, and 1,197 ft. On the 115-ft. formation one level was opened; 683-ft. formation—a south level was driven 320 ft. and an underlie shaft sunk to a vertical depth of 730 ft.; 905-ft. formation—a level driven south-east 160 ft.; 1,039-ft. formation—a level driven north-east 500 ft.; 1,197-ft. formation—a level driven east 240 ft. These were all unpayable and no returns are recorded. The ground is now abandoned.

MINES AROUND TOWERS HILL.

These include the mines on the Wellington and Moonstone Flats, as well as those immediately to the south of the Day Dawn lode, amongst the latter being the North Australian workings, which mark the site of the original discovery of gold on the field. Several of the reefs in this area have produced important amounts of gold, notably the Wellington, North Australian, and Rainbow, but the majority of the reefs worked have been small, and have not so far proved to carry payable ore to any considerable depth. Shallow workings are numerous, and have afforded good returns to small parties of prospectors, as portions of the area contain numerous small auriferous veins. At the present time Clark's Gold Mine and the Papuan (Moonstone) are the chief producing mines of this part of the field.

New Queen Cross Mine.

This mine is on Moonstone Flat, near the Gap, Towers Hill, and is situated on G.M.L. 2396, area 44 acres, held by the New Queen Cross Gold Mines, Limited. The manager is Mr. R.

Plate 35.—New Queen Cross Mine.

(Welcome Mine in right centre.) Output 1911–1916: 6,515 tons of ore, value £29,620; dividends £2,500.

Kirkbride. The company has been working on the Moonstone reef since 1911, but below a depth of 120 ft. it has mostly proved unpayable. At present the reef is being opened up at a greater

Scale of Chains
0 2 4 6 8 16 24

G.M.L.2495
Clark's G.M.Co

G.M.L.2467
W. Caspar

G.M.L. 2439
Clark's G.M.Co

G.M.L.2494
Clark's G.M.Co

G.M.L.2436

CLAIM
Clark's G.M Sh.

Clark's G.M.Co.

North Australian Reef

Rainbow Reef

Lady Maria Underlie Sh.

Maria Reef

G.M.L.2484
Reservoir
T.Byrne & E.H.T. Plant

G.M.L.2499
Papuan Brilliant & Victoria

TOWERS HILL

Old underlie Sh.

New Queen Cross Sh.

Clark's Moonstone Reef

G.M.L.2474

G.M.L.2933
Union Lease

Union Reef

G.M.L.
KELLY'S WELCOME & UNION LEASES
2432
Welcome Lease

Welcome

Kelly's Sh.

G.M.L. 2447

Reef

Moonstone

G.M.L.2396
New Queen Cross G.M. Co.

Vertical Sh D 798'

G.M.L.2457
St George & Moonstone G.M.Co.

No 2. S.E.D.D. Sh

G.M.L.2514
A Bowry

G.M.L.2504
Moonstone & Telegraph

G.M.L.2513
Madelaine Lease

Madelaine Reef

Iron Duke Sh

Reef

Gray's Wellington Sh

Wellington

Telegraph Reef

Gold Mining Leases around Towers Hill.

Plan 16.

NEW QUEEN CROSS MINE

Plan of Workings

depth (on the 275-ft. level), and a little stoping is in progress in the intervening levels, while a few tributers are working in the old stopes of the upper levels.

The returns from the mine to date are as follows:—

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1911 ..	45	33	48	148	..
1912 ..	86	120	275	665	..
1913 ..	1,716	2,084	4,066	10,797	2,500
1914 ..	2,220	1,933	3,302	9,376	..
1915 ..	1,274	1,019	1,415	4,548	..
1916 ..	1,174	534	2,406	4,086	..

The strike of the Moonstone reef approximates to 65 degrees east of north, and it dips to the south-east at an average angle of 23 degrees. The direction of dip is thus abnormal for the field, for all other reefs approximating to the general east-west strike dip to the north. On this reef a small pay shoot has been worked in this mine and the Papuan adjoining, but the development work in these mines and in the No. 2 South-east Day Dawn (Perseverance) has demonstrated its general poverty to a depth of at least 200 ft. Since the exhaustion of the ore shoot above No. 3 level, operations have proved disappointing although prospecting work has been kept going perseveringly. The work done in two adjoining mines and in the shaft of the St. George and Moonstone lease offers very little encouragement for any body of payable ore in the further prospecting of this fissure.

The company in 1916 opened up a small shoot of ore in No. 6 south-west level (v.d. 275 ft.). At that level it extends from between 400 to 500 ft. from the shaft, the width of ore ranging from 1 ft. to 2 ft. in thickness. It has been followed down 100 ft. by winze to No. 7 level, which is proving its lateral extent there. Stoping is in progress between No. 6 and No. 7 levels on this shoot.

Underground Workings.—The mine is worked by an underlie shaft from the surface, which at the beginning of 1916 had attained a depth of 280 ft. There are six levels east and west from the shaft. From the surface to No. 3 level (v.d. 121 ft.) the old stopes extend from 160 ft. west of the shaft to the Papuan boundary. Below this level the formation has been mostly unpayable. On the east side No. 4 and No. 5 levels, driven 60 ft. and 170 ft. respectively, have located nothing payable. No. 6 level has been driven south-west over 500 ft. and a winze sunk to No. 7 on the ore shoot now being opened on the latter level.

(See plan No. 17.) The underlie shaft shows a clearly defined fissure to the bottom, and below No. 5 level carries up to 1 ft. of quartz splashed with sulphides. This is considered too low-grade to work.

Papuan (Moonstone) Mine.

The mine adjoins the New Queen Cross on Moonstone Flat, near The Gap, Towers Hill. The lease is G.M.L. 2499, area 50 acres, held by the Papuan, Brilliant, and Victoria G.M. Company. Mr. G. Ross is mine manager. The company, since the abandonment of operations on their Queenton lease in 1911, has worked this mine with satisfactory results.

Production.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1912 ..	856	815	2,465	5,131	1,200
1913 ..	1,802	2,899	3,085	12,448	4,800
1914 ..	1,275	1,396	5,480	9,952	2,460
1915 ..	2,618	2,944	11,392	20,813	7,200
1916 ..	1,960	2,074	6,223	12,986	1,200

Two reefs have been worked, viz., the Moonstone and a "cross" reef which was intersected in driving No. 4 level on the Moonstone.

The *Moonstone* reef, described under the preceding mine, was worked to a depth of 160 ft. On the whole it has been poor but a small pay shoot co-extensive with the New Queen Cross shoot adjoining, was worked down to the No. 3 level (v.d. 117 ft.) between the underlie shaft and the south-west boundary a distance of 140- to 200 ft. The reef branched and both branches were worked as well as several cross veins ("tie reefs") connecting the hanging and footwall reefs. The returns during 1912 and 1913 came from these workings. No. 2 and No. 4 north-east levels, driven 300 ft., did not locate any payable ore east of the shaft. The reef has not been opened up in this mine below the No. 4 level on account of its poorness. This level carries 2- to 3 ft. of quartz immediately east of the underlie, but is too low-grade to work. Had the St. George and Moonstone shaft struck payable ore on this reef the company would have continued the sinking of the underlie, but all development work has long ceased as the prospects in the deeper ground are not encouraging.

The "cross" reef, the existence of which had hitherto been unsuspected, was intersected in No. 4 level, 300 ft. east of the Moonstone reef underlie. Its bearing is about 25 deg. west

THE PAPUAN BRILLIANT & VICTORIA MINE

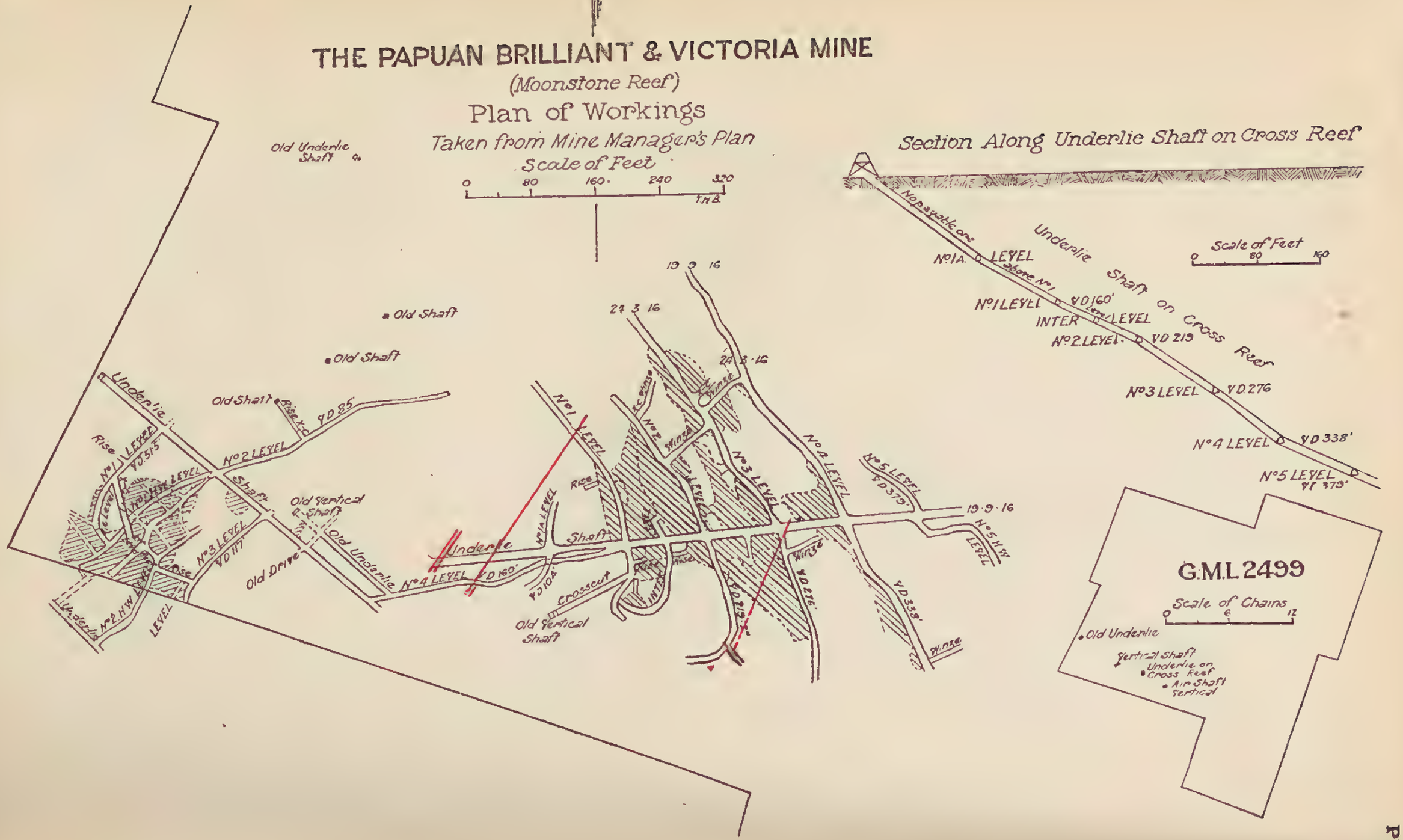
(Moonstone Reef)

Plan of Workings

Taken from Mine Manager's Plan

Scale of Feet

0 80 160 240 320



of north, and angle of dip 34 deg. to north of east. From No. 1 level (v.d. 160 ft.) to No. 4 level (v.d. 338 ft.) a rich pay shoot has been worked averaging in value £7 18s. per ton. The reef, however, is narrow, showing great fluctuations, from a mere thread of quartz to four or five feet in occasional bunches, the average thickness of the reef stoped being about 8 in. It has only been proved laterally for 600 ft. between No. 1 and No. 4 levels, and this area includes a number of barren patches in the formation. The underlie shaft recently opened up to the surface on this reef formation did not disclose any payable ore above No. 1 level.

All this evidence does not establish hope that the mine will be a large or sustained contributor to the future gold yield of the field, and as a result of recent development the prospects are hardly so bright as early in 1916. The fissure is so small and the shoot worked so irregular and restricted in width that the persistency of a payable thickness of reef to any great depth is hardly to be expected. It is a mine whose future prospects should show considerable fluctuations as small shoots are further revealed and worked out. Further prospecting work, both laterally and in sinking, will probably encounter these. In developing the mine crosscutting into the hanging-wall country should receive consideration, as the history of the older mines on the Day Dawn and Brilliant lodes has shown so often the presence of unsuspected parallel reefs.

The country rock is hard grano-diorite and several of the older series of diorite porphyrite dykes, faulted by the ore fissures, are present. These have been plotted on the plan of the underground workings.

Underground Workings.—On the Moonstone reef an underlie shaft goes down to the No. 4 level (v.d. 160 ft.). On the west of this shaft there are three levels on the footwall reef (No. 3 v.d. 117 ft.) and two levels on the hanging-wall (v.d. 55 and 85 ft.). These all extend to the New Queen Cross boundary, and it is here the old stopes are situated, but no work has now been done there for several years. No. 2 and No. 4 north-east levels, driven 300 ft. from the shaft, comprise the only work done to the east of the shaft by the present company.

The " cross " reef is now worked by an underlie from the surface, thus obviating the extra haulage along the Moonstone underlie and No. 4 level. The following notes on the development work were written in September, 1916:—

No. 1A Level (v.d. 104 ft.), 50 feet north, 50 ft. south; no payable ore in sight. *No. 1 Level* (v.d. 160 ft.), 240 ft. north, 35 ft. south; stoped out above level to 105 ft. north of shaft; end in unpayable formation. No. 4

Moonstone level connects at plat, and the south level connects by 100 ft. crosscut to old vertical shaft (up cast). There is a short interlevel between No. 1 and No. 2.

No. 2 Level (v.d. 219 ft.), 204 ft. north, 160 ft. south; stoped out to 160 ft. north and 30 ft. south of shaft. The south level near the end is in broken country with two formations, one dipping south and the other north-east.

No. 3 Level (v.d. 276 ft.), 321 ft. north, 190 ft. south; the overhead stopes extend from 130 ft. south of shaft to 240 ft north on reef averaging 8 in, thick. The north end shews about 3 in. of ore.

No 4 Level (v.d. 338 ft.), north 239 ft., south 221 ft.; in the south level. 184 ft. from the shaft, the footwall carries a reef to the end showing a high grade ore up to 18 in. thick, now being stoped, the remainder of the level carries several inches of fair quality ore with blanks of mullock intervening. In the north level the reef is being stoped for 100 ft. from shaft. In the end the reef has died out, but the soft black formation, impregnated with sulphides, looks promising for further ore in driving.

No. 5 Level (v.d. 379 ft.), is being opened out north and south, and near the shaft carries 1 ft. of poor quality ore. The underlie shaft between No. 4 and 5 levels carries a low grade reef 18 in. thick.

Since the above notes were written, the underlie shaft has been carried down 215 ft. from the No. 5 plat, and No. 6 level is being driven at a point 167 ft. down.

PLATE 36.—WORKINGS ON THE MOONSTONE.

Papuan Mine (old shaft) in the foreground, Clark's Gold Mine on hill.

Clark's Gold Mine (Moonstone Lease).

G.M.Ls. 2436, 2439, and 2494, total area 69 acres 3 roods 8 perches, held by Clark's Gold Mines, Ltd., are situated south-west of the City, adjacent to The Gap, Towers Hill, and Moonstone Flat. The mine manager is Mr. M. Lewis. The main shaft and recent workings are situated on G.M.L. 2436, and the Lady Maria underlie shaft, to which the present workings are now connected, lies about 370 yards to the north-west, on G.M.L. 2439.

The Company has been working this mine since the year 1914. There are two groups of old workings within the leases, viz., on the Moonstone reef (termed Clark's Moonstone to distinguish it from the reef worked in the Papuan and New Queen Cross) and on the Lady Maria and Hidden Treasure reefs. The Lady Maria reef is at present being worked, and small shoots of very rich ore to the south of the old workings have been located below the 426-ft. level. The output is small as the reef, although fluctuating to anything up to 18 in. in thickness, does not average more than about 6 in. of payable stone. The crushings during 1914-1916 averaged £9 7s. 4d. per ton.

Production.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.
	Tons.	Crude oz.	£	£
1914	348	1,185	577	4,652
1915	1,241	3,137	1,725	12,509
1916	1,899	3,831	2,456	15,558

The Lady Maria reef has a bearing approximating to 25 deg. west of north and dips easterly at an average angle of 45 deg., from which there are local variations. The reef fissure averages a width of about 2 ft. between walls.

This mine created a feeling of optimism on the field when the rich crushings of 1914-1915 were put through. The reef is, however, too small to expect a large output which would effectively assist in retrieving the declining yield of the field. The development work in No. 6 level has shown a satisfactory grade of ore, though recent crushings have fallen a little from the high value previously maintained, and the reef is more regular with less blanks of mullock intervening than in Nos. 4 and 5 levels. As the fissure has been small from the surface to a depth of 600 ft. it cannot be expected to increase in size in further sinking beyond occasional bulges such as are charac-

teristic of all the ore-bearing fissures of the field. From the size and lateral extent of the ore fissure it would be undue optimism to anticipate the persistency of a payable thickness of reef to any great depth. Up to the end of 1915 a large amount of dead work in developing the mine had been done, which included the dewatering and cleaning up of the Lady Maria underlie shaft, Nos. 5, 6, and 7 levels, and the driving of these levels to connect with the main workings. The mine is now in a position to profit from this work and an increased output should be immediately maintained.

Geological Features.—The wall rock varies from the normal grano-diorite in the south workings to a fine-grained quartz diorite in the lower levels to the north. The change is insensible, there being no line of demarcation. Vertical dykes of both series of diorite-porphyrite are present to the north of the main shaft and are seen at the surface and in the underground workings. The older dykes are a continuation of a group passing through Mills United and the Day Dawn Block and Wyndham mines, further to the north-east. They are faulted by the ore fissure, the dyke plotted on underground plan in the No. 4 level at 156 ft. north of No. 2 underlie shaft showing a lateral displacement of 10 ft. between the faulted portion on the hanging-wall and that on the footwall. This agrees with the evidence showing only a small movement for the formation of the other lode fissures on the field. The dykes vary from a few inches to 2½ ft. in thickness.

Three faults, approximately vertical, have been detected in the underground workings. They are of later occurrence than the ore fissure, but the amount of movement seen in the reef is small. They have a parallel bearing, 105 deg. east of north, and are plotted on the underground plan. The most northerly shows a vertical upthrow of 2 ft. to the south, which is well seen in No. 3 and No. 4 levels. In the former level the fault shows as a band of soft crushed grano-diorite from 6 in. to 1 ft. thick. The reef there on both sides of the fault was small but very rich. The prill ore, however, does not follow the line of intersection, for in No. 5 the reef is particularly small and of poor quality near the fault. The small movement of the reef proves that the two footwall fissures at No. 5 level are distinct from the main ore fissure. The two other faults do not show any noticeable displacement of the reef, although in the No. 3 crosscut a vertical dyke is faulted by one of them. A small lateral movement could effect this without any marked throw in a reef dipping at an angle of 45 deg. and intersected at a small angle by the fault.

CLARK'S (MOONSTONE) COLD MINE

Plan of Workings

Taken from Mine Manager's Plan

Dykes (in red) & Faults Plotted from Geological Survey

Stoping Reference

Present Workings

Old Workings (Lady Maria Reef)

Old Workings (Moonstone Reef)

Scale of Feet

0 80 160 240 320

Plan 19.

Underground Workings.—The main working shaft is vertical to a depth exceeding 426 ft., at which depth it intersected the reef. It is at the south end of the present workings and is situated on a hill, the altitude of the shaft collar exceeding that of the old underlie shaft (Lady Maria) by 68 ft. The No. 2 level (v.d. 378 ft.) is connected by crosscut to the vertical shaft and extends 120 ft. north. No. 3 level (v.d. 426 ft.) extends 500 ft. north of shaft. At 180 ft. therefrom a footwall level on a small vein fissure branches off extending further north 160 ft. From the main No. 3 level, 340 ft. from shaft, No. 2 underlie has been sunk to No. 5 level. Overhead of No. 3 the reef is too small to profitably work. Underfoot of No. 3 the reef carried fair to good quality ore varying up to 10 in. thick for a distance of 320 ft., with intervening blanks aggregating about 150 ft. This level extends south from main shaft for 160 ft., at which distance it cut a vein formation dipping north (Clark's Moonstone reef (?)). No payable ore was discovered in the south level. No. 4 level (v.d. 469 ft.) extends north almost to the stopes of the old Lady Maria Mine. Overhead the stopes extend for 520 ft., including blanks equal to about 100 ft. The crushings here averaged about £13 per ton, but the reef was erratic in size and kept pinching out. No. 5 level (v.d. 527 ft.) extends from 85 ft. south of No. 2 underlie to the Lady Maria underlie. A footwall vein opened up at the No. 2 underlie showed no payable ore. No. 6 level was extended from the Lady Maria workings to the No. 2 underlie. It is to be driven south to connect with No. 1 underlie, which is being sunk below No. 4 level. Another underlie (No. 3) is being sunk from No. 6 level at a point 220 ft. north of the No. 2 underlie. Early in 1917 this had been carried down to No. 8 level, which carries up to 8 in. of heavily mineralized ore. No. 7 level (v.d. 650 ft.) is being driven north and south from No. 3 underlie on this shoot of ore, which appears to be a continuation of that worked at a shallower depth in the Lady Maria Mine. A crosscut was driven 112 ft. into the hanging-wall country from No. 3 level in the hope of picking up the continuation of the Hidden Treasure branch reef, but without success.

Kelly's Welcome and Union Leases.

The abandoned ground, including the old Union and the Welcome mines, situated to the south-west of the city, was taken up in the year 1912 by Kelly's Queen Block G.M. Company. The present leases comprise G.M.Ls. 2432 (12 acres), 2433 (5 acres), 2474 (25 acres), and 2477 (5 acres). A shaft was sunk to the

north of the old workings on the Welcome reef to a depth of 30 ft. by this Company, but operations were then suspended owing to want of capital.

In 1916 operations were again started at the old underlie shaft, the workings from which were unwatered and cleaned out, and the No. 4 level extended about 30 ft. without any promising developments. No. 2 west level was driven a further 15 ft. and is reported to have exposed 8 in. of fair mineralised ore. Apparently under the mining conditions the prospects were not considered sufficiently encouraging, for it is proposed to abandon work here and prospect the Union reef on the Company's leases.

Both the Union and Welcome mines were worked in the early days of the field and most of the crushings were obtained prior to 1890. Since then they have been worked to some extent by tributers. The following returns (exclusive of tributers' parcels) are recorded in the Warden's office:—Union reef, 2,184 tons of ore, 4,457 oz. gold; Welcome reef, 1,893 tons of ore, 3,982 oz. gold (residues, value £1,011).

The following are particulars of the old workings.

Union Reef.—The reef strikes 110 deg. east of north and dips north-easterly at an angle of 50 deg. The two principal shafts were the Union P.C. and the Union G.M. Company's. The former, situated 4½ chains south-east of the latter, is vertical for 35 ft. and then follows the reef on the underlie to a depth of 250 ft. The reef was opened up by three levels for a distance of 150 ft. Between No. 1 and No. 2 north-west levels the ground has been stoped for 100 ft. from the shaft. Between Nos. 2 and 3 levels the reef has been stoped for 30 ft. on both sides of the underlie shaft. No. 3 level (the lowest) is 224 ft. deep. The Union G.M. Company's shaft follows the reef to a depth of about 300 ft. and two short levels were put in north-west (see plan No. 20).

Welcome Reef.—The reef strikes 140 deg. east of north and and dips north-easterly. Two underlie shafts were sunk on the reef, the deepest for a distance of 424 ft. from the outcrop, and five levels were opened up. Near the surface the workings extend for a distance of 200 ft. and most of the ore was obtained from above a depth of 150 ft. (see plan No. 20). Heavy water and the small size of the reef were responsible for the abandonment of the mine, which from the high-grade ore revealed in the returns appears to merit further development.

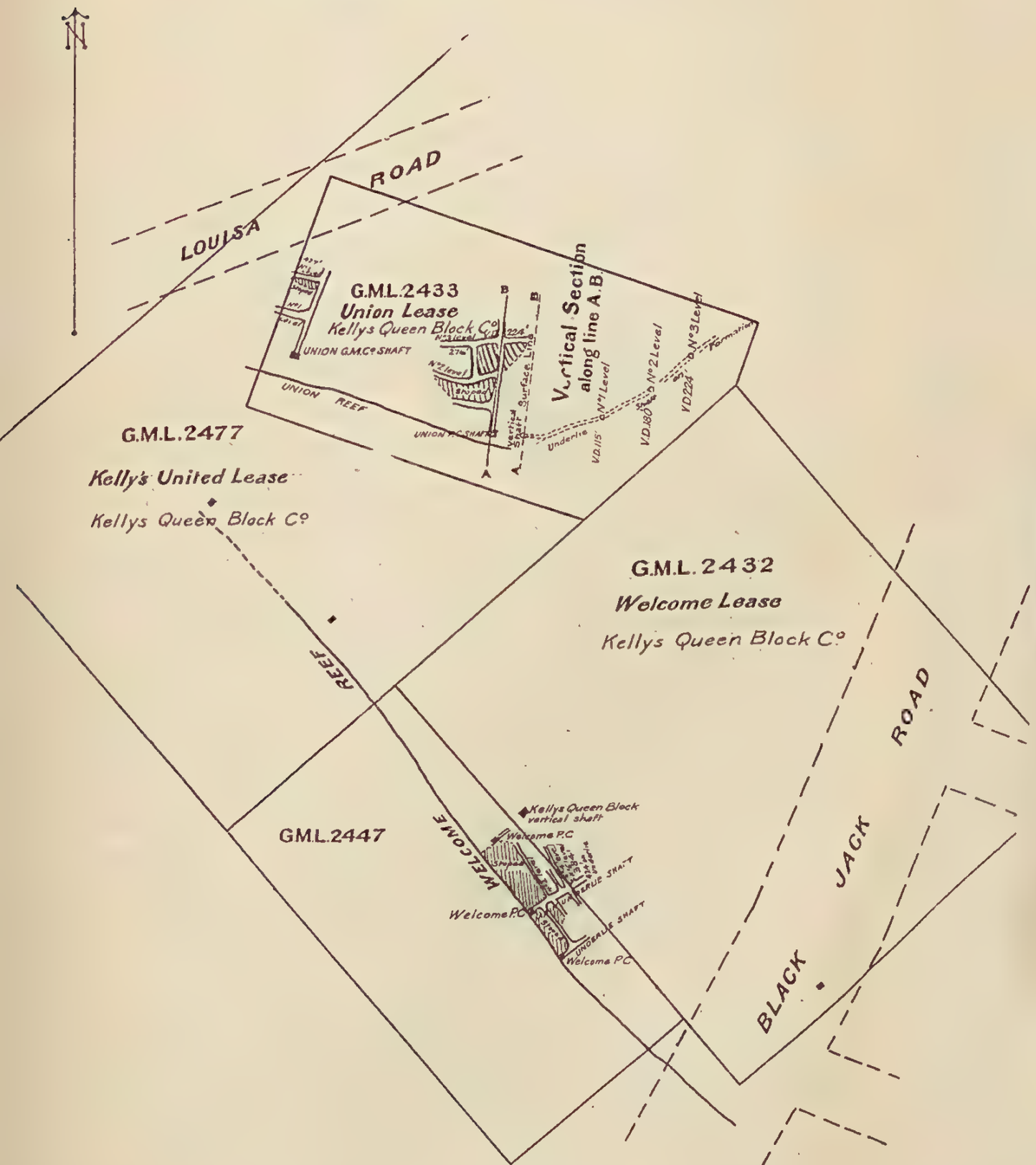
PLAN

Of Union and Welcome Leases and old Workings

Workings & Sections taken from Plans supplied by Secretary, Kelly's Queen Block G.M.Co

Scale

Feet 132 66 0 2 4 Chains



Madelaine Mine.

G.L. 2513, area 11 acres, situated south-west of Charters Towers, near the old Wellington Mine. The Madelaine reef is being opened up just to the east of the old underlie shaft. The reef strikes a little to the north of east and dips northerly at an angle of about 40 deg. A new underlie shaft, started in 1915, has been sunk, and at 131 ft. from the surface on the ore fissure, it penetrated the bottom east level of the old workings, the water from which flooded the shaft and rendered inspection impossible when the mine was visited (April, 1916). The mine was again visited in September, 1916, when the shaft had been sunk to 150 ft. (on the underlay) and two levels opened up. The maximum width of the reef formation is from 2 ft. to 3 ft. and less on an average. The formation has proved decidedly patchy, about 12 in. being the maximum thickness of the reef exposed, part of which was "buck" quartz. Small shoots of gossanous ore up to 6 in. thick were seen. The reef is being further tested by sinking, but the prospects of obtaining any considerable tonnage of payable ore look unpromising.

Returns for 1916:—Ore raised, 75 tons, yield 114·5 oz. gold, value of residues £123. Total value £495.

Moonstone-Telegraph Mine.

This small mine, or rather prospect, is situated about two miles south-west of Charters Towers, and is in line with the Wellington workings. The ground was held as Extended Claim No. 9660 by Messrs. J. Williams, J. Rea, and party. It has been worked since 1914 by this party without success, and work was discontinued in the latter part of 1916 after prospecting work had been done to a depth of 124 ft. The Telegraph vein here is faulted by three small, nearly vertical, faults, but no enrichment of the vein occurred down to the depth mentioned. A full account of the recent workings appeared in the "Queensland Government Mining Journal" for May, 1916 (see List of Literature).

Returns.—*Old workings,* 178 tons of ore, 139 oz. gold; *new workings,* 1915, 72 tons of ore, total value £142; 1916, 91 tons of ore, total value £271.

St. George and Moonstone Lease.

A vertical shaft, subsidized by the Government, was recently sunk on the St. George and Moonstone lease (G.M.L. 2457), situated on the south side of the city. The principal object was to intersect the Moonstone reef, worked in the Papuan and the New Queen Cross leases to the north-west, but being close to the

south-west extension of the main auriferous belt of the field, it was considered valuable prospecting work in the quite reasonable hope of intersecting hitherto undetected lode fissures. The Moonstone reef outcrops about 22 chains north-west of the shaft and, dipping south-east at an angle of 23 deg. in underground

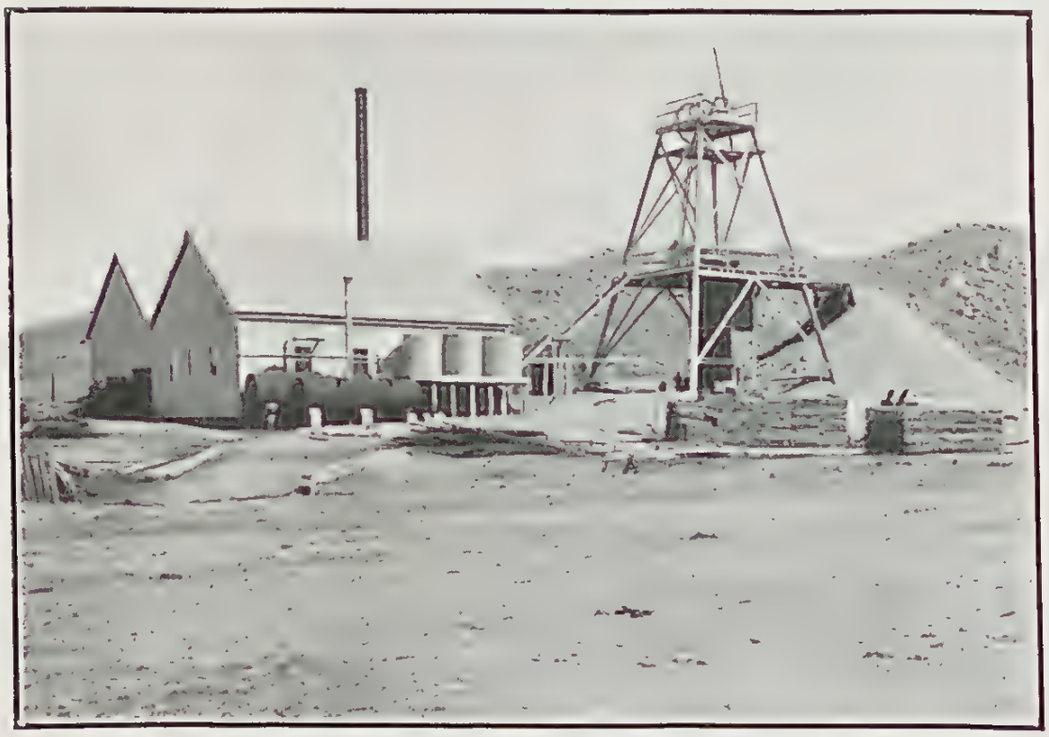


PLATE 37. — ST. GEORGE AND MOONSTONE SHAFT.
Depth, 798 feet.

workings to a depth of 200 ft., it was estimated at the same angle of dip it would be cut in the St. George shaft at 590 ft. During 1915 the shaft was sunk to a depth of 798 ft. in grano-diorite without finding any prospects of a payable reef, and operations were suspended. The country where the shaft is situated is intersected with numerous diorite-porphyrite dykes, but dykes of the same series are faulted by the Moonstone reef in the Papuan Mine and have therefore not affected the position of the reef.

No. 2 S.E. DAY DAWN (PERSEVERANCE) MINE.

The No. 2 South-East Day Dawn G.M. Company, after carrying on mining operations on the Day Dawn line of lode unsuccessfully for many years, took up G.M.L. 2367 in 1910, embracing the old Perseverance Mine. This mine is situated on Moonstone Flat, about 1½ mile south-west of the city. The reef worked here, formerly known as the Perseverance, strikes north-east to south-west and dips south-easterly at an angle of 23 deg. It is almost certainly a continuation of the Moonstone reef

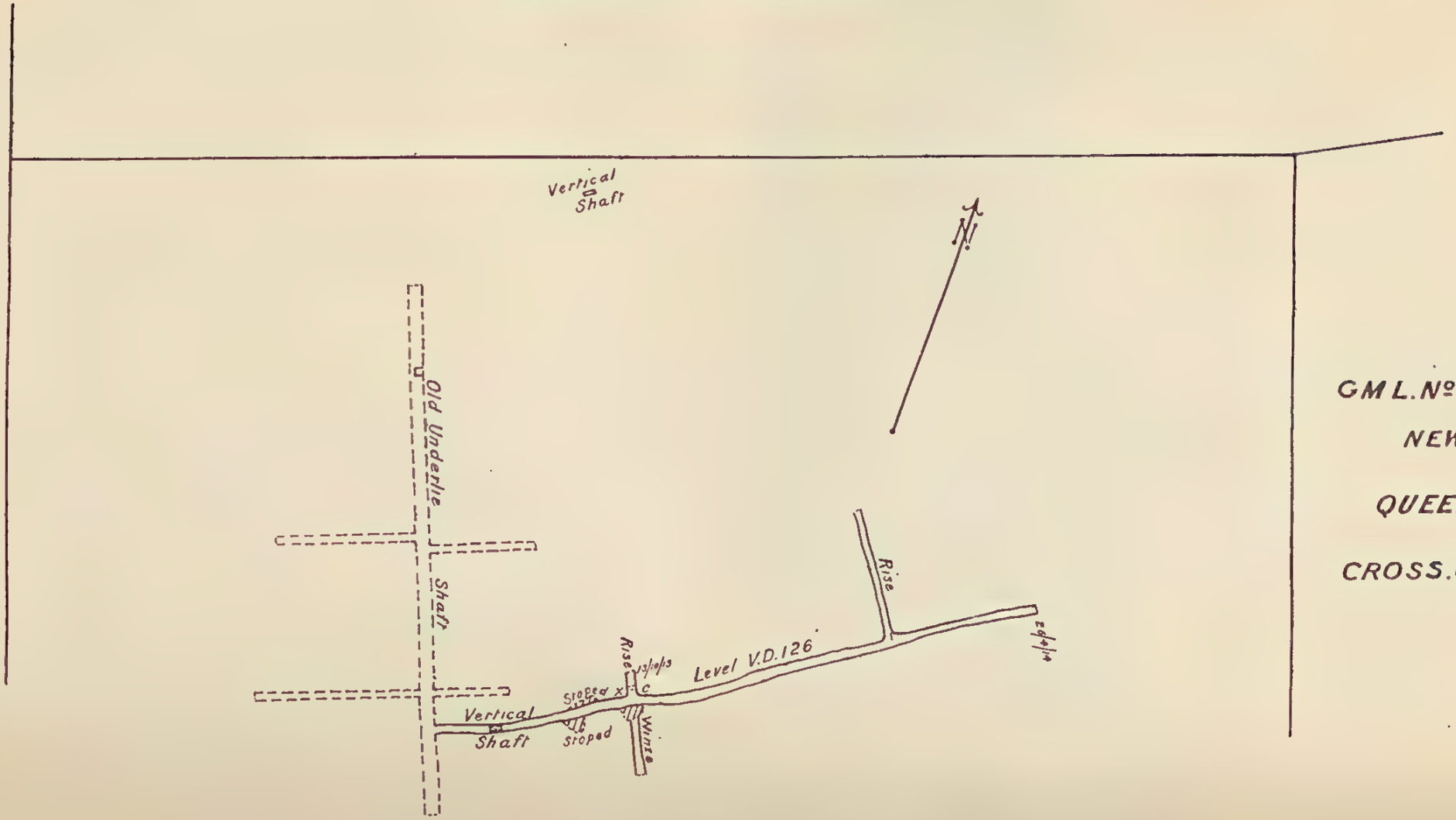
No.2 SOUTH EAST DAY DAWN MINE

(Perseverance Mine)

Plan of Workings

Scale

Feet 0 80 160 240 320 Feet



G.M.L. No. 2396

NEW

QUEEN

CROSS.G.M.Co

Plan 21.

worked further east, in the Papuan and New Queen Cross mines, with which it agrees in position, strike, and angle of dip. In this ground it has been very poor, the fissure often being quite devoid of quartz. From the old Perseverance Mine 272 oz. of gold were won, and since operations were recommenced in 1910 only a few unpayable trial crushings have been put through. The new company continued the old underlie shaft to a depth of 170 ft. on the fissure without meeting any ore. A vertical shaft was then sunk which intersected the fissure at 126 ft., and at that depth a level was driven north-east for 480 ft. A winze was put down 60 ft. on a small body of quartz at a distance of 120 ft. from the shaft, and 340 ft. from the shaft a rise was put up 120 ft. No payable ore was found, and since 1914 operations have been suspended. There are two east and west levels off the old underlie shaft above a depth of 100 ft., the former being 40 ft. and the latter about 60 ft. in length. A definite fissure with good hanging and foot walls is revealed by the 126-ft. level for nearly 500 ft., averaging a width of about 4 ft. from wall to wall, but it is practically barren of quartz for the whole distance. A number of diorite porphyrite dykes are intersected by the fissure, and no change in the geological character of the country from that of the auriferous areas accounts for the impoverishment of the fissure here.

Wellington Mine.

This old mine is situated in the south-west quarter of the city area. The ground has been worked since the earliest days of the field, and until 1889, a number of claims were being worked on the Wellington reef, including Nos. 1 and 2 Wellington (Millett's), No. 3 Wellington (Guy's), and the Lord Nelson and the Iron Duke. The ground was then taken up under a 20-acre lease known as Millett's Wellington, which embraced the greater portion of the above-mentioned claims, and was worked successfully by the company until 1901, when the mine was worked on tribute. Up to the end of 1888 the five claims crushed ore yielding approximately 29,083 oz. of gold. Some of the ore was exceptionally high-grade, the Iron Duke crushings for 1887 averaging 4½ oz. of gold. From 1889 to 1900 the mine raised 9,286 tons of ore for 16,589 oz. of gold, exclusive of tributers' returns. The total returns are 45,672 oz. gold from 25,664 tons of ore, an average of nearly 2 oz. per ton. This includes 1,080 oz. from the Lord Nelson reef, a hanging-wall vein on the Wellington reef. The Wellington reef strikes nearly east and west and dips northerly at an angle of 35 deg. In the Iron Duke claim it dips north-easterly and strikes south-east. The Iron Duke workings are connected to Millett's Wellington workings underground,

proving the trend of the reef to alter in the eastern ground. In this claim an underlie shaft was sunk on the reef from the outcrop to a depth of 350 ft. Flooding of the deeper levels obliged the tributers working there to close down. In Millett's Wellington lease the reef has been worked to a depth of about 450 ft. To that depth it varied up to a maximum thickness of 15 in. Two underlie shafts were put down to the lowest workings and the mine plan shows a large amount of stoping done from the surface to the 340-ft. level for a distance of 300 ft. along the levels. In Guy's Wellington (No. 3) claim the reef was worked to a depth of about 250 ft. on the western extension of the reef. The Lord Nelson reef was worked to a depth of 200 ft. in the old claim from a surface underlie shaft. In the bottom level of Millett's Wellington mine, the reef was faulted and it was not located on the northern side of the fault. The line of intersection of fault and reef bears north of east, the fault hading south-east at a low angle. This means that in the Iron Duke extension of the reef to the south the intersection of the fault will be met with at a greater depth, and that there should be at least a depth of 150 ft. below the workings near the shaft before the reef will be faulted, while further south that figure will gradually increase, depending on the angle of inclination of the fault. It therefore appears to offer a fairly reasonable prospect of profitable operations should it ever be reworked from the Iron Duke shaft. Work on this reef has long been abandoned and all surface machinery and appliances have been removed.

North Australian Mine.

This is the oldest mine on the field, for it was here that the first discovery of gold was made in 1871 by Messrs. Mosman, Fraser, and Clarke. The North Australian P.C. shaft stands just below The Gap, to the south-west of the city. Up to 1885 the North Australian reef was worked in a large number of claims, of which the P.C. claim and Nos. 1 to 5 on the line were included in the lease subsequently taken up by the Mosman Gold Mines Ltd. This company worked the mine until the year 1898, but the ground has been taken up a number of times since, although very little work has been done except to the east, where the North Australian and Peabody reefs have been opened up below a depth of 1,000 ft. in the North Australian Block Mine and later in the Talisman and New Dawn mines. Prior to 1885 most of the gold was obtained in Mosman's P.C. and the No. 3 claims, the crushings recorded averaging 2 to 4 oz. of gold per ton. Many thousands of ounces of gold were won from the claims in the early days, but the complete records are not pre-

served. The following returns do not include 1872 to 1874 nor July to December, 1875:—

Period.	Mine.	Ore Raised.	Gold.
		Tons.	Oz.
1875-1883 ..	North Australian P.C. (Mosman's)	3,346	6,893
1875-1884 ..	North Australian No. 3 Claim ..	6,583	15,147
1875-1883 ..	North Australian No. 4 Claim ..	1,316	2,529
1884-1897 ..	Mosman's Gold Mines (N. Australian Lease)	14,650	28,487

The great bulk of the gold came from the North Australian reef, a small percentage coming from a footwall reef known as the P.C. reef. The company worked to a depth of over 700 ft. from the No. 1 underlie shaft. For 500 ft. north and 250 ft. south of this shaft the reef was payable near the surface, but the ore-shoot narrowed to 100 ft. at the 530-ft. level and below that again only occasional patches of payable ore were found. The total yield from the two reefs must have exceeded 60,000 oz. of gold. Tributers worked the mine until the year 1908.

Rainbow P.C. Mine.

This mine included the claims formerly known as the Rainbow P.C., Nos. 1, 2, and 3 south, and No. 1 north, which had been worked as early as the year 1872. It is situated close to the city, behind the Day Dawn ridge. The early returns from the claims are not complete, but the crushings were very rich. From 1886 to 1896 the returns show 14,000 oz. of gold won, but the crushings prior to that from the claims, obtained from unofficial sources, would increase that to a total of nearly 40,000 oz. from the lease. The reef, dipping east, was worked to a depth of 700 ft., but below 600 ft. was not payable. Most of the ore came from the south side of the main shaft, but levels tested the reef for a distance of 450 ft. on each side of the shaft. No work has been done for many years.

Eastward Ho Mine.

This mine is situated on the Wyndham-Rainbow line of reef, close to the Day Dawn ridge. It was last worked by Mosman Gold Mines Ltd. up to the year 1898. The reef has been worked from two shafts. No. 1 shaft on the outcrop of the reef follows the reef to a depth of about 600 ft. Below this the workings are connected to the Wyndham Mine levels. In the eastern ground of the lease the Wyndham No. 2 underlie shaft has been continued into the Eastward Ho to a depth of 1,100 ft. Very little payable ore was found here. Some remarkably rich crushings came from the upper levels near No. 1 shaft. In 1885 the return from 1,741 tons of ore amounted to 8,389 oz. gold.

From 1876 to 1894 the gold production was 28,105 oz. from 13,100 tons of ore crushed. Tributers worked in the mine until the year 1905, but the returns were very small and no work has since been done.

Talisman Mine.

This was formerly known as the North Australian Block Mine. The Talisman and New Dawn G.M. Company acquired the mine under G.M.Ls. 2062 and 2158, aggregating an area of 62 acres, situated just south of the Day Dawn Block and Wyndham Mine. The southern portion of G.M.L. 2,062 was the spot where gold was first discovered on the field, and the Alabama, Peabody, and North Australian reefs had previously been worked in this ground, the latter to a depth of about 900 ft. The company's operations were intended to test the ground below these older workings and to prospect for the New Dawn reef, which was worked in the Day Dawn P.C. Mine between 900- and 1,200 ft. deep. The old North Australian Block shaft was repaired in 1906 and subsequently sunk to a depth of 1,800 ft. Nothing of value was found in sinking and a little work was done on the North Australian and Peabody reefs, but neither were payable. There were no returns beyond 302 oz. of gold from a number of trial crushings. The company went into liquidation and the ground was acquired by the Day Dawn P.C. Company in 1910.

THE MILLCHESTER MINES.

The town of Millchester, situated 2 miles south-east of Charters Towers, was an important centre of mining activity from the year 1872 until the failure of the Identity mines about twenty years later. Almost immediately after the original discovery of gold on the field further finds were made along the Identity line, at the Washington and Alexandra reefs a little further south-east, as well as the auriferous alluvial near the present rifle range. Although several other reefs have been worked in the vicinity their yields have been small compared to those from the Identity mines, which were the mainstay of Millchester. The greatest returns were obtained from those mines prior to 1883, for the Identity reef became impoverished at a comparatively shallow depth for this field. Up to the year 1894, however, operations were continually carried on with reduced yields, but since that time the work done in prospecting the deeper levels of the Identity reef, by a number of different companies, has proved unpayable. It is about five years since the last company (the Brilliant and St. George G.M. Co.) suspended operations after unsuccessfully testing the ground to a depth of about 1,000 ft., and since that time the only mining

activity has been the work of small parties of miners working or fossicking on surface "shows." The reefs worked in the past include the Identity, Florence, Golden Surprise, Gladstone, and the Captain.

Geology of Millchester Area.

The Millchester mines lie on the eastern extremity of the second auriferous belt of the field (see page 92). The country rock is the same intrusive (grano-diorite) which occurs over the greater portion of the field. It appears more siliceous than the normal rock described and has sometimes a noticeably gneissic structure, which is seen in the vicinity of the Prudence Mill. Aplitic granite dykes and a subordinate number of pegmatite dykes are prevalent over the area, and many of the former can be traced to the large outcrop of aplitic granite situated half a mile to the east of Gladstone Creek. Around the mines the diorite-porphyrite dykes are absent as far as the surface indicates but their place is taken by a series of igneous dykes which are approximately similar in mineral composition although very different in physical characters. These dykes have been described as hornblende porphyrites and, in the field, are characterised by the reddish-brown colour of the rock and the needle-shaped crystals of unaltered hornblende which stand out conspicuously from the groundmass. The dykes trend east to west and can be traced for a distance of a mile at the surface. They appear to be genetically connected with the diorite porphyrites although of a more recent intrusive phase (see p. 89). The latter occur abundantly as dykes to the east of Millchester and also about one mile to the west of the town, so there can be little doubt that they continue right through the area although no outcrops were found near the mines. The reef fissures approximate to an east and west strike and all dip northerly at angles ranging from 20 deg. to 35 deg.

The Identity Mines.

None of these abandoned mines could be inspected and their interest appears to be a matter of history, for there is small probability of any of them being again reworked. An outline of the history of operations, the extent of the workings, and the returns is all that can be given from the data available.

The Identity reef strikes approximately north-east and dips to the north-west at an average angle of 30 deg. Several parallel veins have been worked in some of the mines. The original mines on the line of reef were the Identity P.C., No. 1 West Identity, No. 1 and No. 2 East Identity, and the Hit or Miss. Of these the Identity P.C. proved the best and was

worked up to the year 1894. Nos. 1 and 2 East Identity returned some very good crushings up to the year 1885. The No. 1 West Identity was a failure, and the Hit or Miss had several rich crushings from near the surface but was unpayable below a depth of 150 ft. The Hope Mine, a block on the Nos. 1 and 2 East Identity, was taken up a little later and worked with success between the years 1882 and 1885. These mines were all abandoned before 1894 and were again taken up that year and reworked by the Identity United G.M. Co., whose lease (G.M.L. 1686) included the No. 1 West Identity and the western ground (including the underlie shaft) of the Identity P.C., and by the Good Hope G.M. Co., which took up under G.M.Ls. 1642 and 1643 the No. 1 and No. 2 East Identity, the Hope, and portions of the Identity P.C. and Hit or Miss. In addition to these the New Grace Darling was also worked from 1892 to 1900, the lease (G.M.L. 1542) including the Hit or Miss and Grace Darling workings. None of these companies were successful in their prospecting work, which lasted up to the year 1902. The last attempt to work the Identity was made by the Brilliant and St. George G.M. Co., which took up the Good Hope Mine and worked it to a depth of about 1,000 ft. between the years 1908 and 1911. No work has been done since then.

The principal returns are given hereunder:—

Period.	Mine.	Ore Raised.	Gold.
		Tons.	Crude oz.
1875–1893 ..	Identity P.C.	15,714	28,107
1875–1885 ..	Identity, No. 1 East	2,516	5,511
1875–1881 ..	Identity, No. 2 East	2,671	4,359
1880–1889 ..	Hope	8,034	9,788
1892–1900 ..	New Grace Darling	..	2,231
1896–1901 ..	Good Hope	2,672	2,029
1898–1900 ..	Identity United	1,094	1,207
			Value of ore.
1908–1911 ..	Good Hope (Brill. & St. George)	762	£3,837

The Identity reef was worked to a depth of 600 ft. The plans of the shallow workings have not been preserved, but little work appears to have been done west of the underlie shaft. The lowest east level (No. 8) is connected to the Good Hope workings and the intervening country above No. 8 is worked out. The P.C. ground abandoned in 1894 was again taken up, the west portion by the Identity United and the eastern by the Good Hope.

No. 1 West Identity Mine.—This was one of the original mines on the reef, as its name implies—immediately to the west

of the P.C. Mine. It has been tested to a depth of 500 ft. but the ore shoot did not extend into this mine.

Lady Florence Mine.

This mine is situated on the east side of Gladstone Creek, Millchester. It was taken up under G.M.L. 1586, area 25 acres, by Frederick Shaw in the year 1893, and was worked until 1904 by the Lady Florence G.M. Company. From 1894 to 1903 9,276 tons of ore were raised, which yielded 4,241 oz. of gold. The Lady Florence reef strikes from east to west and dips north at an angle of 30 deg. The fissure was small, the reef averaging less than 1 ft. in thickness, and it was not traced for more than a quarter of a mile near the surface. The mine was worked from an underlie shaft sunk from the surface on the reef to a depth of 560 ft. Six levels were driven, the longest being No. 3 west, 500 ft., and No. 4 east, 240 ft. The ore raised averaged 11 dwt. of gold—an unpayable proposition on this field for a small reef under normal conditions. The reef was worked to a small extent in the adjoining ground on the east and west by the Lady Florence No. 1 East and No. 1 West companies, but the returns were probably less than 100 oz. In the No. 1 west an underlie shaft was sunk to a depth of 150 ft. and the No. 3 west level v.d. 258 ft.) was driven from the Lady Florence a distance of 100 ft. west of the boundary without striking anything payable.

Captain P.C. Workings.

A group of surface workings about half a mile south of Millchester indicates the location of the Captain vein. It was evidently only a shallow vein and most of the work was done over twenty-five years ago. The vein fissure strikes 85 deg. east of north and dips northerly. The returns available at the Warden's Office show only 208 tons of quartz raised, which returned 258 oz. of gold.

Gladstone P.C. Mine.

The mines on the Gladstone reef are situated on the western side of Millchester, close to the Identity mines. The Gladstone reef has an east-west strike and dips northerly at an angle of 45 deg. Shallow shafts and potholes are numerous along the position where the reef outcropped for a distance of about 10 chains, but judging by the length of the reef and the size of it (reported to have averaged about 6 in. thick) there were no hopes of its permanency beyond a few hundred feet from the surface. As most of the work was done prior to 1880 it has been impossible to obtain the complete returns and a record of all the workings.

The following returns from the leases along the Gladstone reef are taken from the records in the Warden's Office, Charters Towers:—

Period.	Mine.	Ore Raised.	Gold.
		Tons.	Oz.
1875-1882 ..	Gladstone Extended Mine ..	1,341	1,709
1878-1884 ..	Gladstone No. 1 West Mine ..	414	380
1886-1891 ..	Gladstone Gold M. Co. (P.C. Mine)	481	550
1890	Gladstone P.C. Extended Mine ..	45	113

On the original prospecting claim a vertical shaft was later put down, 5 chains to the north of the outcrop, and cut the reef at a depth of 240 ft. and the reef was opened up by an underlie to a depth of 400 ft. This is the greatest depth it has been tested, but below 300 ft. it was unpayable in these workings. A level was driven for 300 ft. at a depth of 306 ft., and a little stoping was done on the east side of the shaft to that depth. Probably less than 5,000 oz. of gold were obtained from the reef, of which nearly all came from the Gladstone P.C. Mine. The last recorded returns from that mine are for the years 1887 and 1888, when 408 oz. of gold were obtained. The ground was held under successive gold leases till 1905, but very little work has been done during the past twenty years.

Golden Surprise Mine.

This mine is situated near the western boundary of the town of Millchester. The Golden Surprise reef was discovered in 1895 by a miner named Tierney. The reef strikes east to west and dips northerly at an angle averaging 30 deg. The mine was worked between the years 1895 and 1902, the reef becoming too narrow to be followed deeper. During that period 1,579 tons of ore yielded 2,892 oz. The first crushings, within 50 ft. of the surface, averaged 3 oz. of gold per ton and created a mild boom in the area, all the surrounding ground being rushed by applications for leases. To a depth of 200 ft. the pay vein averaged 9 in. thick, but below that it averaged 5 in. to a depth of 400 ft. and became too narrow to be payably worked.

The Golden Surprise lease was G.M.L. 1623, area 20 acres. The underlie shaft on this mine was sunk to a depth of 400 ft. The pay shoot was found 30 ft. below the surface, and the plan shows stoping down to No. 4 level (v.d. 165 ft.). The levels opened up the reef for a width of 300 ft., the pay shoot extending 200 ft. east and 60 ft. west from the shaft.

Craven's Golden Surprise Mine (G.M.L. 1641).

A little work was done on this mine, which adjoined G.M. 1623 (Golden Surprise) to the west. An underlie shaft was sunk to a depth of 130 ft. and two levels opened up. The mine was worked during 1896 to 1897 and 265 tons of ore won, which yielded 560 oz. of gold.

Ruby P.C. Mine.

Situation.—The mine is situated about 2 miles south-east of Charters Towers and to the west of Millchester.

Production.—The mine was worked from the year 1901 to 1912. Operations are still suspended. From 17,884 tons of ore raised during that period, approximately 24,153 oz. of gold were recovered, and dividends amounting to £28,750 were paid. The ore over the whole period averaged in value £6 6s. 4d. per ton.

The yearly returns were as follows:—

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.	Dividends.
	Tons.	Crude oz.	£	£	£
1901 ..	67	96	..	288	..
1902 ..	2,283	2,777	..	12,137	3,750
1903 ..	6,104	6,305	..	25,636	7,500
1904 ..	4,146	5,465	..	24,600	6,250
1905 ..	767	1,259	..	5,723	1,250
1906 ..	536	1,705	..	6,251	1,250
1907 ..	1,661	3,610	1,304	13,432	6,250
1908 ..	1,072	2,755	1,402	10,711	2,500
1909 ..	745	726	315	2,717	..
1910 ..	353	379	185	1,424	..
1911 ..	150	223	126	863	..

Reefs and Ore Shoots.—The plans indicate that two separate reefs have been worked. From No. 1 shaft (the most easterly) the reef worked dips towards 50 deg. west of north at an angle averaging 25 deg. From No. 2 shaft—13 chains further west—the reef worked dips towards 15 deg. west of north at an angle of 23 deg. The workings of the reefs do not approach nearer than 200 ft. to each other, and at this point the eastern reef is 160 ft. deeper than the western. The east levels of the former are reported to have intersected a fault bearing approximately north and south, and the reef was not found to the east of the fault, although very little prospecting work for it appears to have been done. It is therefore possible that the two reefs may have been continuous before faulting, but this assumes a down-

throw to the east of 160 ft., a movement of greater magnitude than has been found on any part of the field, and a distinct change of strike in the reef previous to faulting.

On the eastern reef a small ore shoot has been worked between the depths of 150 ft. (where it passes upwards into the Ruby United Mine) and 420 ft. The shoot averaged 200 ft. wide, but this included many blocks which were considered unpayable. The pitch was almost vertical.

On the western reef a shoot averaging 100 ft. wide and pitching easterly was worked between the vertical shaft (depth 78 ft.) and the 400-ft. level. On the west the levels penetrated a barren fissure and on the east the pay shoot was terminated by a fault.

Underground Workings.—The No. 1 shaft cut the eastern reef at a depth of 290 ft. An underlie shaft was sunk to a depth of 480 ft. and six levels driven east and west, the reef being partially stoped for 150 ft. on either side of the shaft. No. 3 west level (v.d. 347 ft.) was driven nearly 400 ft., but the last 200 ft. was on an unpayable vein. To the south-east of the vertical shaft a narrowing shoot was worked back to the boundary from a rise put up to the 180-ft. level. No. 2 shaft cut the western reef at a depth of about 78 ft. An underlie shaft was sunk from the intersection to a depth of 270 ft. West of this shaft Nos. 1 and 2 levels were each driven 160 ft. No other work was done on this side of the shaft and very little ore was obtained there. On the east side five levels were driven, the longest being No. 5 (v.d. 250), which was put in 250 ft. to the fault. As the shoot was pitching easterly the lower workings were connected to an underlie shaft sunk from the No. 5 level at 200 ft. east of the main underlie shaft. In this portion of the mine the reef was worked to a depth of 450 ft. over a lateral distance of 250 ft. (see Plan No. 22).

Geological Features.—The country rock is grano-diorite and the mine lies on a belt containing numerous diorite-porphyrite dykes of the older series trending north-east to south-west. A conspicuous dyke of aplitic granite running north and south outcrops a few yards to the east of No. 2 shaft. As the data of the field survey shows these dykes to be older than the reefs it is not likely to have affected the reef here in any way. It was impossible to inspect these workings, as they were submerged with water to a shallow depth, so no examination could be made of this dyke or the fault which is reported to cut off the reef in the east levels of the western workings. The reefs have no visible outcrop and have not been worked above a depth of 90 ft.

THE RUBY P.C. & RUBY UNITED MINES

Plan of Workings

Scale
Feet 0 80 160 240 320 Feet

N

Ruby P.C.

Ruby United

Head
Dyke
V.D. 417'
No 8 Level
Footwall
Shaft
369.9'
Level V.D.
No 7
V.D. 307.6
No 6 Level
No 5 Level
V.D. 250'
Underlie Shaft
Dyke
No 4 Level V.D. 199.7'
No 3 Level V.D. 165.8'
Inter Level
No 2 Level V.D. 118.4'
Level V.D. 98'
Slide
Air Way
Winze
Dyke
No 1 Level V.D. 100'
No 2 Shaft

V.D. 452'
Winze
Dyke
No 7 Level V.D. 467'
Underlie
No 6 Level V.D. 423'
Slide
Level V.D. 398'
No 5
No 4 Level
V.D. 373'
Shaft
No 1 Shaft
V.D. 289'
Inter Level
No 3 Level V.D. 347'
Rise
Fault
No 2 Level
Reef
V.D. 339'
V.D. 212'
Winze
Rise
No 1 Level
V.D. 242'
No 1A Level
Pass

Shaft
No 5 Level V.D. 226'
Winze
X-Cut
Level
V.D. 281'
V.D. 237'
Level V.D. 160'
No 2 Level
V.D. 120'
Rise
Winze
Underlie
V.D. 67'
No 2 Shaft
Underlie
S.W. Crosscut
Slide
Rise
No 3 Windlass Shaft
V.D. 88'

Creek
Excelsior Mill
Millchester
Ruby United 50 ac.
Ruby and Macdonald United 12 ac.
Ruby P.C. 50 ac.
No 1
No 2
Ruby No 1 East 24 ac.
Ruby United East 25 ac.
Ruby Extended 35 ac.
Ruby South 10 ac.

PLAN of THE RUBY GROUP OF LEASES

(Leases Cancelled)
Scale of Chains
8 6 4 2 0 8 16 24

As they are narrow and have a length apparently limited to a few hundred yards near the surface, it is not likely that they would prove persistent fissures to any appreciable depth below the present workings.

Between the eastern and western workings is a strip of country from 200 to 400 ft. wide. On both sides of this strip small but rich shoots of gold were worked to a depth exceeding 400 ft., returning over 24,000 oz. of gold. The western reef was lost by faulting and as the eastern reef does not appear to be the same, the intervening country between the workings is well worthy of exploration either by a small prospecting shaft or crosscuts from the shallower levels of the old workings.

Ruby United Mine.

This mine adjoins the Ruby P.C. The ore shoot worked in that mine from the No. 1 shaft was also worked in the United between the depth of 80 ft. and 150 ft. The returns were small, for, although several other veins have been explored, very little further ore was found. The only returns recorded were:—

Year.	Ore Raised.	Gold.	Dividends.
	Tons.	Crude oz.	£
1904	1.727	3,266	8,000
1905	1,633	1,123	1,000

Most of this ore came from the Ruby P.C. shoot, which was worked from No. 3 shaft, near the west boundary of the lease. The shaft cut the reef at a depth of 90 ft. The shoot was 50 ft. wide, and was worked from the No. 3 shaft to the boundary, a distance of 100 ft. The ore averaged 30 dwt. of gold per ton. At a distance of 160 ft. north-west of the No. 3 shaft an underlie shaft was sunk from the surface on a vein formation to a depth of 400 ft., but no payable ore was found. The bearing of this shaft is 10 deg. east of north. Near the west boundary of the lease No. 1 and No. 2 shafts were sunk vertically, cutting quartz veins at 75 ft. and 157 ft. respectively. Apart from several hundred tons of payable ore stoped near the shaft on the 75-ft. vein, no fissures carrying ore were revealed, although a number of small veins were found, the ground here being prospected by numerous crosscuts to a depth of 220 ft. (see Plan No. 22).

THE OUTSIDE MINES.

While over 90 per cent. of the gold yield of the Charters Towers field has been derived from mines situated within or close to the city, there are a number of mines scattered over the

outlying country (for location consult Plate 1), several of which have contributed considerable amounts of gold in the past. These are known as the "outside" mines, and while some of them have yielded very rich ore they are not marked by either the size or persistency of the lode fissures of the city and closely surrounding area. This accounts for the fact that beyond two mines—the Stockholm and the Cumberland United mines—they have now all been abandoned. Like the main group of lodes, the outside reefs are all contained in grano-diorite, part of the one large intrusion. Diorite-porphyrite dykes are distributed to some extent over the whole area, but are probably more abundant than the geological map indicates, for the heavy surface soil and the comparative absence of rock outcrops render their detection more difficult than in parts of the city and adjacent areas. It can be said that the geological occurrence of the outside reefs differs in no more material aspects from the lodes of the city area than that the reefs are smaller and impersistent and that the diorite-porphyrite dykes are not so concentrated in occurrence and not nearly so numerous. In the ore from widely separated mines there is no greater variation in its character than that noticeable in the city mines. It consists of quartz with pyrite galena and zincblende in that order of abundance. Of the mines within the area mapped, reference has been made in past reports by Dr. R. L. Jack,* E. J. Laun,† and E. O. Marks.‡ With perhaps five exceptions the reefs have been unimportant, and of the others it is difficult to obtain more than meagre details, for some of them have not been worked for many years.

Stockholm Mine.

This mine is situated about 4 miles south-west of Charters Towers, on G.M.L. 2501, area 24 acres. It is now owned by the Brilliant G.M. Company, but at present is being worked on tribute. It is the best equipped and has proved the most productive of the outside mines. The mine is connected by a branch line to the Great Northern Railway.

History and Production.—The mine was first worked in 1873 by West and partner. It was never very payable near the surface, and it changed hands frequently prior to 1885, at one period being worked by the Comstock G.M. Company, when it was known as the Comstock Mine. About 1885 the Stockholm P.C. Company took over the ground, and it was worked success-

* R. L. Jack. G.S.Q. Pub. No. 1 (see list of literature).

† E. J. Laun. Some "Outside" Mines, Charters Towers. "Queensland Government Mining Journal," March, 1911.

‡ E. O. Marks. Q'land Geol. Sur., Pub. No. 238, 1913.

STOCKHOLM (BRILLIANT G. M. Co.) MINE

Plan of Underground Workings

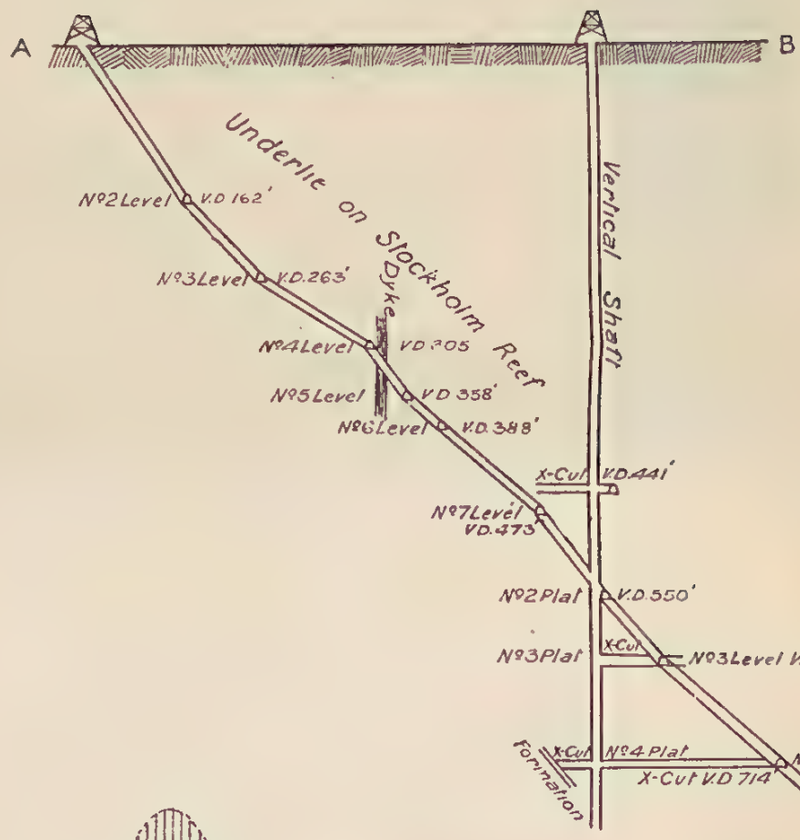
Stoping Reference

Stockholm Reef

'Cross Reef"

Scale of Feet

80 40 0 80 160 240 320



Vertical Section along Line AB

Scale

Feet 0 50 100 200 300 Feet

No 6 Level V.D 868'
Underlie Shaft
No 7 Level V.D. 909'
No 8 Level V.D. 958'
No 9 Level V.D. 1001'
No 10 Level V.D 1029'
No 11 Level V.D 1055'
No 12 Level V.D. 1095'
No 13 Level V.D 1152'
No 14 Level V.D. 1219'
No 15 Level V.D. 1251'
Underlie Shaft on 'Cross' Reef

Vertical Section along Line C.D. on Cross Reef

Scale

Feet 0 50 100 200 300

Plan 23.

fully till 1895, when the returns fell away and it was let on tribute. It was finally abandoned and was then taken up by the Brilliant G.M. Company in 1905, who in the deeper workings opened up the cross-reef dipping to the south, which has surpassed the Stockholm reef in productiveness. The greatest yield was obtained in 1910, when 13,878 tons of ore were raised for gold and concentrates valued at £43,412. Since then the yield has decreased and for the past three years the mine has been wholly on tribute.

The returns from 1875 to 1901 were 26,463 tons of ore, yielding 28,674 oz. of gold. From 1902 to 1906 inclusive there were no returns.

STOCKHOLM (BRILLIANT GOLD MINING COMPANY) RETURNS.

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.
	Tons.	Crude oz.	£	£
1907	3,412	1,234	6,125	9,863
1908	9,935	3,725	13,226	24,705
1909	13,600	6,077	20,787	39,466
1910	13,878	6,559	23,553	43,412
1911	10,517	5,452	18,782	35,554
1912	7,858	4,945	15,866	31,202
1913	4,062	2,270	6,187	13,152
1914	4,844	3,636	5,808	16,800
1915	1,950	1,755	3,041	8,406
1916	1,148	567	1,012	2,698

Underground Workings.—Two reefs have been worked—viz., the old Stockholm and a "cross" reef.

The former, worked from the surface to a depth of 800 ft., below which it was unpayable, has an approximately north and south strike and dips east at an angle varying from 45 deg. to 55 deg. The "cross" reef strikes east and west, with a low angle of dip, which averages 24 deg.

There are two shafts. The old underlie shaft follows the lode formation from the surface to a depth of 550 ft. and seven levels off this extend 100 ft. north and 500 ft. south. No. 2 shaft (vertical) is 150 ft. south of the line of the old shaft and cut the reef at 550 ft. (No. 2 level). The reef down to No. 4 level (v.d. 714 ft.) was worked through crosscuts from the shaft. From No. 4 south an underlie follows the reef to a depth of 958 ft., the bottom of which connects by crosscut to the main underlie shaft on the "cross" reef. On this reef there are two underlies, one from No. 6 to No. 8 level and the lower from No. 8 (v.d. 958 ft.) to No. 15 level (v.d. 1,251 ft.). The

ore from this reef has thus had to be hauled successively through underlie shaft, No. 8 crosscut (270 ft. long), underlie shaft, No. 4 level, and crosscut (400 ft. long) to the vertical shaft, thence to the surface, at an excessive cost.

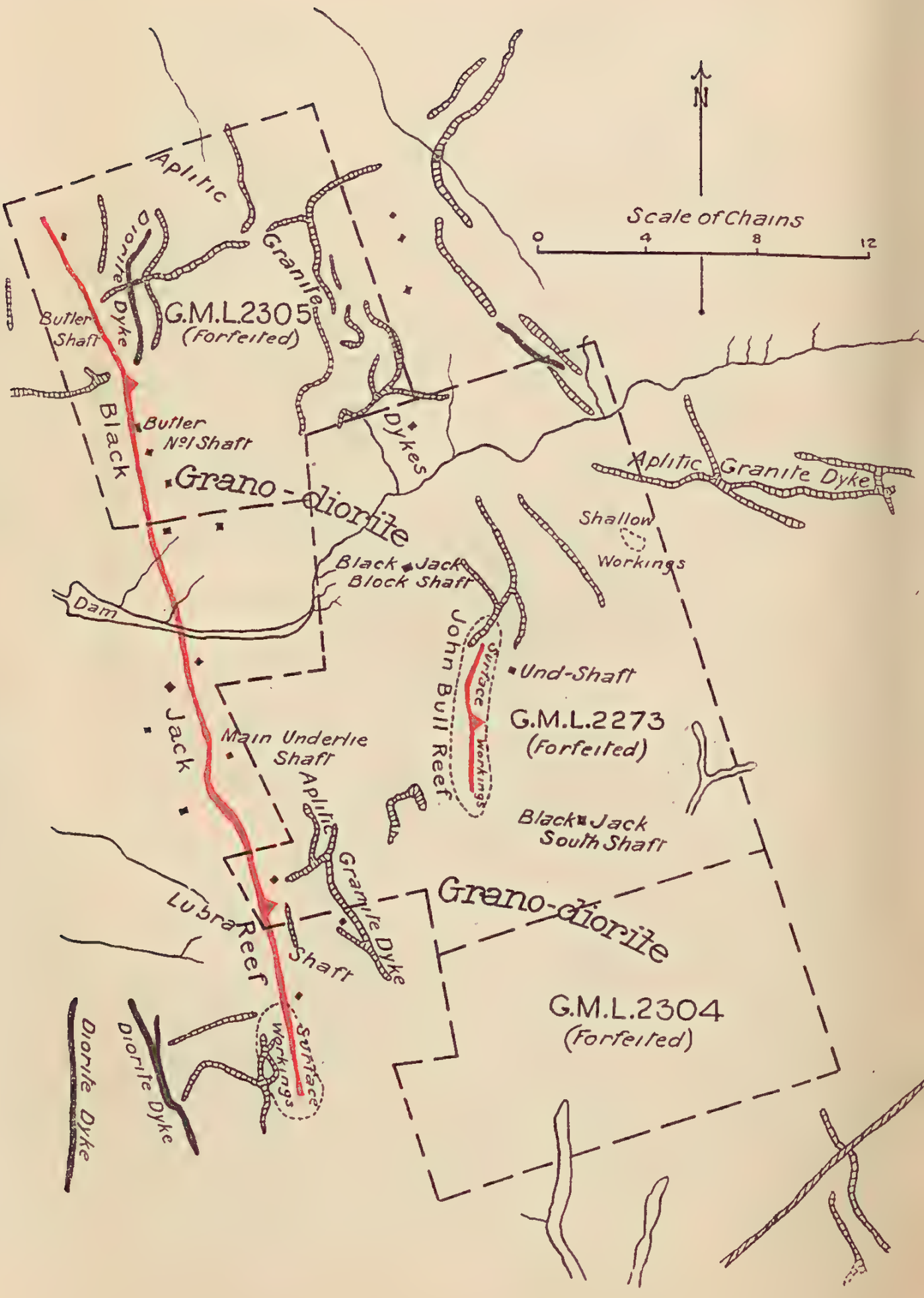
Pay Shoots.—The shoot on the Stockholm reef pitches slightly to the south in depth across the old underlie shaft and extends from the 150-ft. level to a depth of 800 ft. The greatest stope width on this shoot was 450 ft., between No. 4 level (v.d. 301 ft.) and No. 7 level (v.d. 469 ft.). Like the other reefs of the field, this apparently showed the same variation in thickness. The manager stated that they had 14 ft. of ore in No. 2, lower level. This ore shoot averaged about 22 dwt. of gold per ton. The pay shoot on the "cross" reef extended from about the 600-ft. level to a depth of 1,150 ft., and pitches slightly east in depth, the maximum width being about 400 ft. between No. 8 level (v.d. 958 ft.) and No. 10 level (v.d. 1,029 ft.). Isolated bodies of ore have been worked to a depth of 1,250 ft., but in No. 15 level and the bottom of the underlie the payable class of ore is too small to work. In No. 14 east level the face showed 18 in. of ½-oz. stone and only 4 in. of good mineral stone (payable). The reef carrying the pay shoot varied up to 3 ft. in thickness and averaged about 18 dwt. of gold per ton.

Cumberland United Mine.

This mine is situated about 5 miles south of Charters Towers and prior to 1913 was known as the Cumberland P.C. Mine. Very little work has been done in the last two years. Mr. E. O. Marks, formerly Assistant Government Geologist, examined and reported on the mine in 1913* and I quote his report thereon:—

Cumberland P.C. is an old mine reopened, with conspicuous success, in 1908. An underlie shaft has been sunk 335 feet on an incline of 50° to the north-east. At the time of the writer's visit the No. 2 level to the south-east was the only one connecting with an old underlie shaft 220 ft. from the new one. The depth of the old shaft was not known at that time, the old workings not being accessible, though these have since been cleaned out, with, it is reported, satisfactory results. In the No. 2 north-west level the reef is thrown 15 ft. to the hanging-wall by a crosscourse. It then branches into two, the hanging-wall branch continuing in the same direction, while the footwall branch strikes almost east and west, with a much flatter dip to the north. Both reefs vary greatly in quality and up to perhaps 3 ft. in thickness. The footwall branch joining the other above the third level, only one reef is known below that, though possibly it may have continued through into the hanging-wall. The footwall branch has been worked down to a fault, beyond which it has not been picked up, and which cuts it off a little above No. 3 level. A winze 25 ft. below No. 3 level was showing 2 ft. 6 in. of good stone. Beyond the slide which cuts off the footwall reef the No. 3

* Pub. No. 238 Geol. Sur. Queensland, 1913.


N
Scale of Chains
0
4
8
12
Aplitic
Granite
Diorite Dyke
Butler Shaft
G.M.L.2305
(Forfeited)
Black
Butler No.1 Shaft
Grano-diorite
Dykes
Aplitic Granite Dyke
Shallow Workings
Black Jack Block Shaft
Dam
John Bull Reef
Surface Workings
Und-Shaft
G.M.L.2273
(Forfeited)
Jack
Main Underlie Shaft
Aplitic
Granite Dyke
Black Jack South Shaft
Lubra Reef
Shaft
Grano-diorite
G.M.L.2304
(Forfeited)
Surface Workings
Diorite Dyke
Diorite Dyke

level turns somewhat to the left and exposes a vein of fair looking mineral stone in granite walls, though the dark "formation" further back leaves one in some doubt as to whether the main reef should not be sought in the hanging-wall. The bottom (No. 4) level west was 128 ft. from the shaft, with more or less quartz all the way, though not of the size, nor apparently of the same high quality, as that obtained higher up. In the end it was split into several small leaders in a great thickness of dark "formation."

Since this report was written the underlie shaft has been sunk to a depth of 390 ft. and No. 6 level (v.d. 384 ft.) driven 110 ft. east and 115 ft. west and a block of ore stoped for 50 ft. from the shaft to the east. The mine paid handsomely for a few years, the crushings coming from between the surface and No. 4 level (v.d. 239 ft.). The pay shoot extended from 200 ft. north-west of the shaft to the old underlie situated 220 ft. south-east of the shaft.

The following are the returns since the mine was reworked in 1908:—

Year.	Ore Raised.	Gold.	Value of Concentrates and Tailings.	Total Value of Ore.
	Tons.	Oz.	£	£
1909	980	1,289	3,883	7,542
1910	2,117	1,266	10,276	14,146
1911	1,617	1,405	8,257	12,497
1912	2,121	1,254	4,831	8,505
1913	741	366	1,960	3,096
1914	308	223	398	977
1915	185	115	175	482

Black Jack Mines.

The abandoned Black Jack group of mines is situated about 5 miles south-west of Charters Towers. The reef was first discovered and worked in 1875 by Messrs. John Thomas, C. Riley, and J. Byrne, who obtained several payable crushings and then abandoned the mine. It was worked intermittently by different parties until in 1886 it created one of the strong mining booms on the field by the discovery of a rich reef in the lower workings of the Black Jack P.C. Mine. Immediately all the surrounding ground was taken up and for half a mile along the reef the country is covered with mullock heaps and a large number of shafts, which indicate the mining activity prevailing at the time. The boom only lasted three years and the mines were then let on tribute. Several attempts at reworking did not meet with success. As recently as 1912 a local syndicate—the Peter and Jack—were working several of the mines, but since then operations have been suspended.

BLACK JACK P.C.

The Black Jack reef strikes 15 deg. west of north and dips easterly at an angle of 30 deg. In this mine the reef has been worked by an underlie shaft for 600 ft. to a vertical depth of 300 ft. Seven levels were put in north and south. The ore shoot worked was 200 ft. wide above No. 5 level, where a good deal of the rich ore was obtained, the reef in places containing up to 3 ft. of ore, averaging over 2 oz. of gold per ton. In No. 6 and No. 7 levels a lot of low-grade ore is reported to have been left in the mine. In No. 7 level the reef at times attained a thickness of 5 ft. Most of the crushings came from between No. 1 and No. 4 levels, the stope width of the ore shoot being 400 ft. at No. 2 level (v.d. 122 ft.). The abandonment of the mine appears to have been attributable to the decline of values in the two lower levels. During the boom years 1886-1889, 16,226 tons of ore were raised, yielding 20,796 oz. of gold, and dividends amounting to £20,000 were paid.

The individual yearly returns were as follows:—

Year.	Ore Raised.	Gold.
	Tons.	Crude oz.
1886	4,187	8,834
1887	5,037	8,438
1888	1,999	2,312
1889	500	1,212

After being idle for many years the Peter and Jack syndicate worked the mine from 1910 to 1912, and recovered gold to the value of £5,000 from a small reef in the hanging-wall of the old workings.

BLACK JACK BLOCK.

This mine was worked during the boom years. It lies to the east of the P.C. mine, and took in the deeper ground on the dip of the reef. The shaft lies about 10 chains north-east of the P.C. shaft. A vertical shaft was sunk and intersected a vein formation at 360 ft., which was considered to be the continuation of the fissure carrying the P.C. ore shoot. It was poor where intersected and the shaft was continued to a depth of 447 ft., where it opened up a footwall reef. A small shoot was worked here the 447-ft. level being driven 200 ft. south on payable ore. An underlie was sunk 110 ft. on the formation from the vertical shaft. Five hundred and sixty tons of ore were taken out, which returned 1,100 oz. of gold.

Black Jack Block Shaft
Formation cut at V.D. 360'
Reef Worked 447'
Shaft
Underlie
Shaft
Dyke
Diorite
Reef
V.D. 115'
Shaft
Underlie
No 4 Level
No 3 Level V.D. 122'
No 2 Level
No 1 Level
No 5 Level
Level
Shaft
V.D. 203'
Level
No 6 Level V.D. 228'
Underlie
No 1 Level
V.D. 81'
Main
Black
Jack
Line of
Reef
Flat
Reef
Lubra Underlie Shaft
BLACK JACK MINES
Plan of underground Workings
Scale of Feet
0
80
160
240
N
Black Jack
South Shaft
(Cut Formation V.D. 388')
former Lease boundary

Plan 25.

LUBRA.

This mine lies to the south of the Black Jack P.C. and took in portion of the outcrop of the same reef. The reef was sunk on for 500 ft. by an underlie shaft to a depth of 250 ft. The returns were small, 490 tons of ore returning 665 oz. of gold.

SOUTH BLACK JACK.

This shaft is situated about 12 chains east of the Lubra and was sunk to a vertical depth of 400 ft. It intersected a formation at 388 ft., which was followed down by underlie for 120 ft. Two levels not exceeding 60 ft. in length were opened off this, but no payable ore was discovered.

IMPERIAL MINE.

This mine is situated about four miles south-east of Charters Towers and within a few hundred yards of that conspicuous sandstone butte—the Little Red Bluff. The Imperial reef has a conspicuous white quartz outcrop up to 6 ft. thick in places. The strike is approximately east to west and from the surface it dips northerly at an angle of 30 deg. Below a depth of 200 ft. the angle increases to 35 deg. The mine has been worked since before the year 1879, for Dr. Jack mentions it in his report of that date. Like most of the outside mines it has since been worked and abandoned many times by different parties of miners and mining companies, for, although the reef was big, most of it was low grade. Prior to 1892 the total output of gold only reached 2,110 oz. From 1893 to 1896 the mine returned 4,770 tons of ore for 5,056 oz. of gold, of which 3,988 oz. were won during the year 1894, and dividends amounting to £1,875 were paid. This was the only profitable year in the record of mining operations. It was again worked during 1900-1, the returns being 6,079 tons of ore and 1,923 oz. of gold, an average of only 6 dwt. per ton. The mine is still idle.

Several underlie shafts have been sunk on the reef. The main shaft followed the reef to a depth of 390 ft., a distance of 750 ft. Seven levels were opened down to that depth. East of the shaft the reef has only been opened up for 200 ft. and very little payable ore was found on that side. Nos. 4 and 6 levels were each driven 500 ft., the first 280 ft. being due west, the last 220 ft. bearing to the south-west. Practically all the ore stoped came from the west levels. The reef throughout averaged about 10 dwt. per ton, but between Nos. 1 and 2 west levels a small patch of ore averaged 2 oz. of gold.

Imperial No. 1 and 2 West Workings.

The Imperial reef crosses the Bluff road to the west of the Imperial Mine and the white quartz outcrop is conspicuous there and is marked by a large number of shallow shafts and mullock heaps. It has been tested to a depth of about 300 ft. in these mines, but it was found unpayable. The returns did not exceed a few hundred ounces of gold.

Warrior Mines.

The Warrior group of mines are situated close to the Bluff road, at a point nearly 4 miles south-east of Charters Towers. The Warrior reef outcrops on the hill of that name and is associated with several small auriferous veins. It has been intermittently worked since the year 1876 with very little success. Most of the work has been done by small parties of miners, who appear to have only cleared wages. The Warrior reef strikes approximately east to west and dips to the north. The complete returns and plans of workings are not available, but the former were very small. On the Warrior Pup lease, just to the north of the outcrop of the reef, a vertical shaft cut a quartz vein at a depth of 55 ft., and a level was driven west for 40 ft. This lease was worked as recently as three years ago, and during 1911-1912, 594 tons of ore were raised for bullion valued at £2,419. The Victoria and Queen G.M. Company a few years ago took up a 25-acre lease on the Warrior line, but after a year's work abandoned it. At the present time no work is being carried out in any of the leases.

Bonnie Doon Mine.

This abandoned mine is situated on the northern bank of Hogsflesh Creek, near the Bluff road, and is about 4½ miles south of Charters Towers. The mine worked a small quartz vein between 1906 and 1910, when 847 tons of ore were raised, from which 1,091 oz. of gold were extracted, the residues returning £1,435. The total value of the ore raised was £4,814, an average value of £5 13s. 8d. per ton.

Silent Friend Workings.

These are an abandoned group of workings on the south side of Hogsflesh Creek, about 5 miles south of Charters Towers. A small quartz vein dipping north at an angle of 30 deg. was worked for a distance of about 200 yards. Three shallow shafts were put down, but the vein was too small to be profitably worked. The returns were 420 tons of ore for 494 oz. of gold.

Golden Alexandra Mine.

The mine is situated between three and four miles south-east of Charters Towers and furnishes one of the many instances of old mines which have been successfully reworked in recent years. Its history goes back to the early days of the field, and it is reported to have yielded many rich crushings to the original prospectors. The records, however, are not complete, but it has been worked almost continuously until 1912. Between 1885 and 1889 it was successfully worked and about 12,000 oz. were won in that period. From 1905 to 1912 it was worked by the Golden Alexandra Company to a depth of nearly 600 ft. with exceptionally good results, as £17,500 were paid in dividends and nearly 50 men were employed. The returns were:

1905-1911 14,266 tons ore, 19,818 oz. gold, concentrates, &c., valued at £11,365.

The Alexandra reef has an irregular strike approximately north-west to south-east and dips north-east at an average angle of 20 deg. A quartz outcrop can still be seen ranging up to 3 ft. thick, and was traced for about 500 yards. There are a great number of shallow shafts along the line of outcrop. There are two shafts, from which the reef was worked at some depth.

No. 1 shaft cut the reef at a depth of 325 ft. and an underlie was sunk to a vertical depth of 520 ft. The lower ore shoot was worked here, the average width of which was 140 ft., and the greatest stope width 250 ft. The shoot pitched to the south-east from above the No. 2 level (v.d. 368 ft.) about 400 ft. north-west of the shaft, down to No. 8 level (v.d. 560 ft.), 300 ft. south-east of the shaft.

No. 2 shaft, which is situated to the north-west of No. 1, cut the reef at a depth of 175 ft. and an underlie was then sunk to a vertical depth of 500 ft., the bottom of which is 400 ft. north-west of No. 1 underlie shaft. The levels here have opened up the reef for 400 ft. south-east and 200 ft. north-west, and isolated patches of ore have been stoped out down to the bottom level (No. 11). No. 8 level (v.d. 382 ft.) is connected to No. 2 level in the other workings.

According to Mr. W. Dyson, a former manager of the mine, diorite-porphyrite dykes were frequently seen in the workings, which is confirmed by the plans, the strike (north-east to south-west) of these dykes indicating that they belong to the older series. According to the same authority the best ore did not come from the reef alongside the dykes.

Mary Lou Mine.

This old prospecting show is situated about 2½ miles south of Charters Towers. It was taken up as a prospecting area about 1905, and has been worked as recently as 1912. It is on the same belt of grano-diorite, traversed by diorite-porphyrite dykes, as the Ruby group of mines. In addition to these dykes two irregular gabbro (?) dykes outcrop alongside the shafts. A good deal of trenching and shallow prospecting work has apparently been done here. A flat vein, about 4 in. thick, carrying free gold when in contact with the gabbro, was worked at a depth of from 50 ft. to 65 ft. The vein was reported to be barren in the grano-diorite country. From 1908 to 1912 the output was 218 tons of quartz returning 808 oz. of gold. The workings are now abandoned, but the ground is worth prospecting to a greater depth alongside the gabbro dykes for further veins, as they seldom occur isolated on this field.

Great Britain Mine.

This mine, situated about a mile west of Charters Towers, has been worked occasionally since about 1875, but has scarcely ever proved payable. It recently had a further trial by Clark's Brilliant and Worcester G.M. Company, but after a little prospecting work was abandoned as unpayable. The shaft collar is in slate country, but apparently it penetrated the grano-diorite at a shallow depth. The strike of the reef is approximately 110 deg. east of north, and it dips north-north-easterly at an angle of 40 deg. An underlie shaft has been sunk for 480 ft. on the fissure and four levels opened out. Most of this work was done prior to 1889. The returns from the mine are 3,208 tons of ore for 2,906 oz. of gold, the majority of which was obtained before the year 1890. In 1911 Clark's Brilliant and Worcester Company took up the Great Britain lease, unwatered the underlie shaft to the bottom and opened out on No. 1 and No. 3 levels. In the former 20 in. of poor quartz was exposed and No. 3 level carried 9 in. of mineralised quartz for 150 ft. A crushing of 50 tons from No. 3 only realised bullion worth £52 and the mine was thereupon abandoned.

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